The Wireless World

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Friday, February 5th, 1937.

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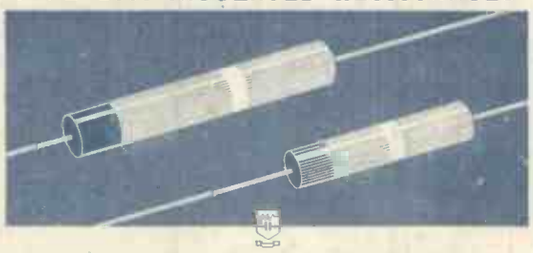

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The Wireless World

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26th Year of Publication

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As many of the circuits and apparatus described in these pages are covered by patents, readers are advised, before making use of them, to satisfy themselves that they would not be infringing patents.

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EDITORIAL COMMENT

Public Address

Growth of an Important Industry

THE issue of *The Wireless World* this week is mainly devoted to the subject of public address, and it is hoped that it will be found a useful guide to equipment available to-day and that the various special articles which have been included in the issue will give some general idea of the varied problems associated with the design and installation of public address apparatus.

So general is the application of sound-amplifying apparatus to-day that it is taken for granted, and in very many cases the public derives benefit from these installations without even being conscious that sound-amplifying equipment is being employed.

Those who had to address large gatherings in the past, even when they were gifted with voices powerful enough to reach their audiences, found that not only were their voices strained in the effort, but the unnatural effect produced was often painful to listen to. To-day speakers can address the largest audiences in a conversational style with freedom from strain and with ability to concentrate on the subject matter rather than the volume intensity of their addresses.

It is difficult to-day to realise how in many spheres we formerly managed to carry on without the assistance of public address equipment, but whilst its use is extending rapidly in all sorts of directions, there still seem to be prejudices, which should be overcome, against its employment in certain spheres. In churches, theatres and music halls, as well as lecture halls, much benefit to listeners would result from the proper installation of equipment of good design. Lecturers who have not trained their voices for public speaking are often quite unconscious of the fact that they are inaudible, and often the more technical the subject matter of a discourse, the less competent from the point of view of intelligibility is the lecturer.

There are still great opportunities in view for extending the use of public address equipment without anticipating that it will be abused to the extent of becoming a public nuisance. No doubt as time goes on some proper control will be needed if existing regulations do not already sufficiently protect the public from the possibility of being subjected to unnecessary noise.

Wireless Demonstrations

An Idea from the U.S.A.

A PROBLEM always facing those whose business it is to sell wireless sets is how to make the prospective purchaser realise that a new set is better than an old one.

It is comparatively easy to demonstrate advances in the way of ease of control, advantages of automatic volume control, tone control and other refinements, but in the all-important matter of quality of reproduction demonstration without strict comparison is very difficult.

To aid the salesman American set manufacturers have devised a special demonstration set which attempts to reproduce the performance of sets of various vintage by means of special controls. A dial is provided, marked with successive years from 1926 to 1936. On turning the dial to any of these figures the loud speaker reproduces the broadcast programmes as would an average set of that date. In this way the year-by-year progress can be demonstrated in a practical manner.

The idea certainly presents possibilities and might well be considered as a promising side-show for the next Radio Exhibition.

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Collaborating with the

SOME PROBLEMS ENCOUNTERED DURING THE INSTALLATION OF A BUILT-IN PA SYSTEM

By P. G. A. H. VOIGT, B.Sc., A.M.I.E.E.

IN buildings designed as headquarters of societies where lectures, meetings and dinners are a frequent occurrence, a permanent sound reinforcing system is often essential. If installed during the erection of the building it can be concealed without sacrificing efficiency as this account of the Royal Empire Society's building shows

THE earliest dwellings of mankind were not provided with means for lighting, heating, ventilating or sound reinforcement, other than such natural features as Dame Nature had provided for in the caves in question.

Since mankind has taken a hand in the erection of its own dwellings and meeting places, the designers—nowadays called architects—have (sometimes with the aid of illuminating, heating and ventilating engineers) paid increasing attention to the earlier of the above factors, and latterly they are also beginning to wake up to the fact that even the last is a matter which can no longer be left to look after itself.

While much can be done by reflecting the sound from the vital points on to the listener by short echoes and reducing as much as possible unnecessary distribution which may later turn into undesired long delay echoes, the human voice is not always powerful enough to give the required coverage even when assisted by correct design from the acoustic point of view.

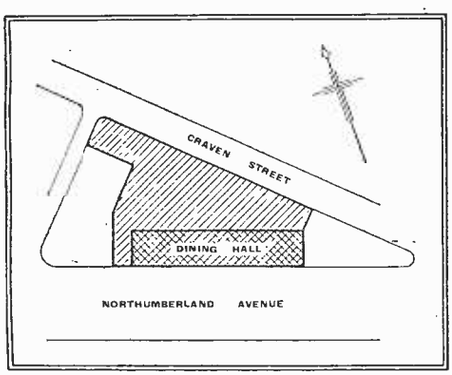

Fig. 1.—Plan showing general shape of the Royal Empire Society's new building. The limitations imposed by the site resulted in a main dining hall very long compared with its width.

As a rule, the electro-acoustic engineer is only called in long after the building is finished, and is expected to remedy serious defects in design or mistaken estimates as to voice-carrying power without interfering with the fabric of the building and with apparatus which, to say the least, is expected to be invisible. Fortunately some of the more enlightened architects have realised that by allowing for and incorporating the necessary apparatus in the fabric of the building at the time of erection, not only can much better results be expected but there is some prospect of concealing the apparatus so that it will not attract attention.

The writer has had the pleasure of collaborating in cases such as this, and it is felt that even though the problems are mainly architectural their solution in three cases (all occurring in the same building) may be of interest.

The building concerned was the new headquarters of the Royal Empire Society (to whom I am indebted for permission to publish the photographs). The architects were Sir Herbert Baker, R.A., and Alex. T. Scott, F.R.I.B.A., and the consulting engineer Dr. Oscar Faber, O.B.E., who kindly permitted extracts from plans to be made.

The new building is situated as shown in Fig. 1 on a site which, while having a very wide frontage, has but little depth. The outline of the main dining hall is shown to scale in Fig. 1. It will be noticed that in plan it is very long compared with the width, the actual dimensions being 130ft. × 29ft. This is shown more clearly in Fig. 2, which shows a plan of the dining hall on a larger scale.

Only those after-dinner speakers with the more robust voices could possibly be expected to be audible at the extreme ends of the hall, and microphone / loud speaker equipment was obviously called for. It was considered that three microphone points would be adequate, one near the middle of the long side by the windows exactly opposite the main entrance and two subsidiary points, one on each side of the central point. It could safely be assumed that the speaker's voice would carry satisfactorily over the central part of the hall, and that reinforcement at the ends only would be required.

As indicated in a previous article[1] reinforced sound, to be natural, should seem to come from approximately the same direction as that from which the original sound is arriving. This requirement called for directional speakers directed away from the centre. To reduce "howl-back" it was also necessary that the loud speaker should not be too near the microphone. The points ultimately selected are those marked X in Fig. 2, the arrows showing the main direction of the horns. It will be noted that for those listening within the beam of the horns the maximum deviation of direction does not exceed about 20 degrees.

Concealing the Loud Speakers

Now arose the case for collaboration. How were the speakers to be fixed and how disguised? The room was in any case to be panelled throughout and the spaces available behind the panelling were too small to conceal high-quality directive horns. The ultimate solution adopted was to modify the curvature of the ceiling cove sufficiently to give the required extra space and to utilise the surface between this cove and the penetration made by the round-headed windows for sound emission purposes. A suitable decorative scheme for the sound exit was satisfactorily devised; this was balanced from an appearance point of view by a corresponding decorative scheme on the opposite face of the win-

[1] Sound Distribution in PA Work, *Wireless World*, March 20th, 1936.

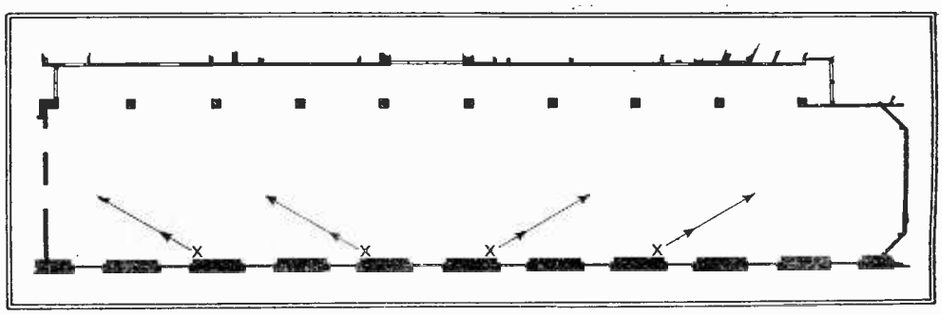

Fig. 2.—Enlarged plan showing disposition of concealed loud speakers in the dining hall. The arrows indicate the main direction of radiation from each unit (X).

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Architect

dow penetration and used for purposes of ventilation.

Normally when a loud speaker is built into position like this it is there for good. In this case, however, owing to collaboration with the architect, suitable inspection covers have been left at the right spot in the floor of the rooms immediately above, and servicing, should it ever be necessary, is simplicity itself.

At the time when the layout was first discussed some bright person had suggested that a small space somewhere in the basement would be a suitable spot for the control engineer. As the dining hall was on the third floor and changing over from one mike to another might be called for, the inconvenience, had this suggestion been carried out can well be imagined. On going very carefully into the plans it was found that one comparatively unimportant room on the same floor as the dining hall had a very high ceiling. The plans were therefore modified, the ceiling of this room lowered, and an excellent amplifier and control room was designed to fit into the space so gained. Although the ceiling is rather low, this room has the merit that its design includes a long narrow observation window through which nearly the whole of the dining hall is visible. Here the control engineer can follow everything that is going on while sitting down comfortably with his hand on the control knob.

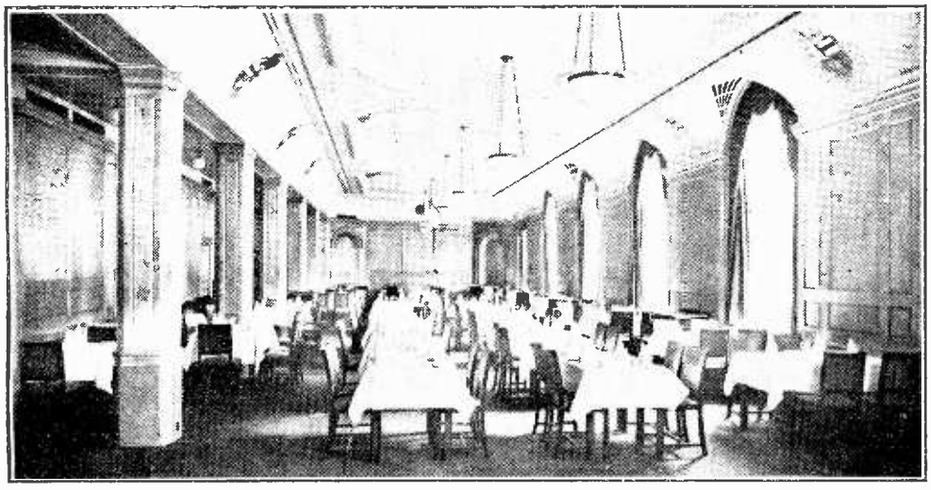

Fig. 3.—General view of a part of the dining hall showing ventilating frets near the top of the windows corresponding to loud speaker frets on the sides nearest the camera. The control engineer's window is also discernible under the ceiling on the left.

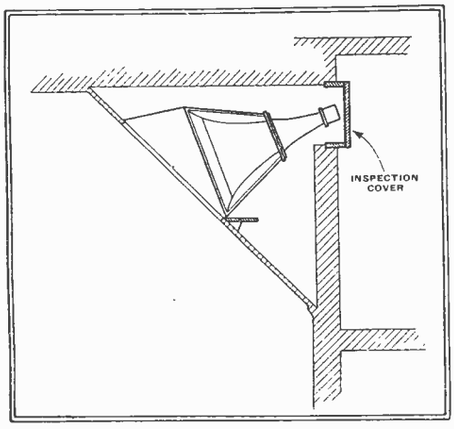

Fig. 4.—Part of the ceiling of the assembly hall was inclined to provide space for the loud-speaker horns. The units are accessible through a cupboard in an adjoining room.

The cable for the B.B.C. mike also terminates in this room, and many a B.B.C. "O.B." engineer will have occasion to bless the architects for putting the control room so exactly in the right spot.

Fig. 3 shows a picture of part of the dining hall (it actually has 10 windows, only 5 show in the photograph). Near the top of one of the windows the decorative ventilating holes can be seen. The speaker openings, which look identical, face these and cannot therefore be seen in this picture. On the extreme left, just below the ceiling by the first pillar, two longitudinal openings can be seen. These serve to admit fresh air. Further down, to the left of the next pillar, a similar opening is visible. This is the observation window from the control room.

So much for the design part. Unfortunately, when everything looks so easy,

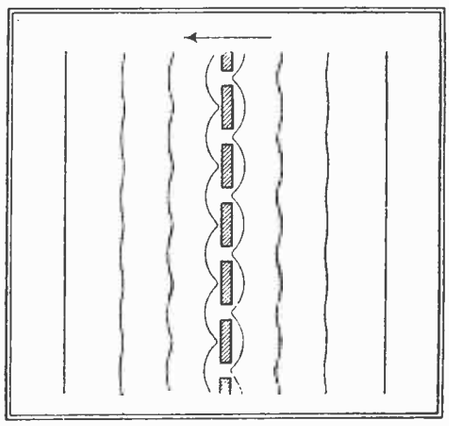

Fig. 5.—Illustrating the passage of a sound wave through cinema screen material.

snags often crop up, and in this case the trouble did not arise until the horns were ready for installation, just before the plaster ceiling was permanently fixed. It was then found that some of the space which the horns should take up was required for the rectangular blind box which must necessarily extend up above the top level of the window. Something had to be done, and the blind boxes could not be modified. The idea of using standard horns as originally intended was therefore abandoned, and special horns, two right-handed and two left-handed, were designed so as to dodge the top corner of the blind box. They were fitted so that the plaster ceiling tended to carry on the horn line, and the result of the modification has had only a small effect on the performance.

The Assembly Hall

The next case to be dealt with was the assembly hall or theatre. This was designed like a miniature theatre and provided with a gallery. Again, loud speakers were called for in spite of the smallness of the hall (400 seats only).

There were several reasons for this. For example, some lecturer might have a voice of well below normal intensity, and bearing in mind that for such a case the ideal spot for the loud speaker is in the line above his head, this spot was suggested. To put the loud speaker on the centre line was out of question, as a large

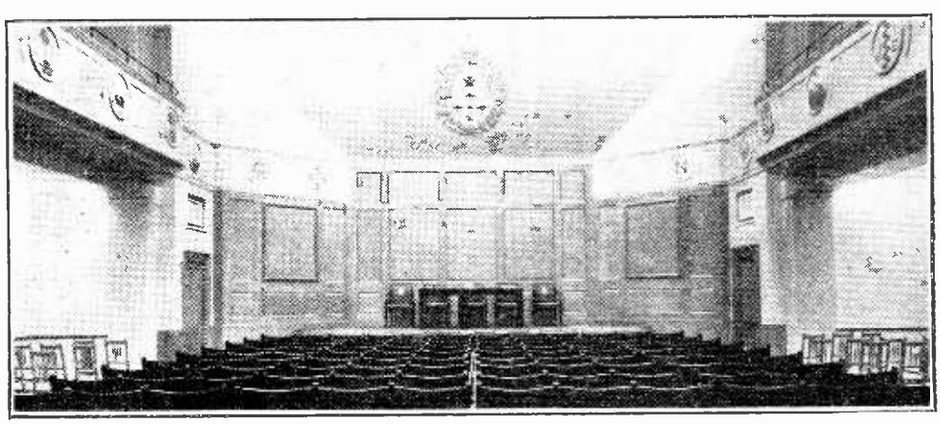

Fig. 6.—General view of the stage in the assembly hall showing sloping ceiling in front of loud speakers.

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Collaborating with the Architect—

symbolic plaster motif was to occupy the centre of the wall or ceiling at this point. To preserve symmetry, therefore, two directional horn speakers were used, one on each side of the centre and directed so as to cross over in front of it.[2]

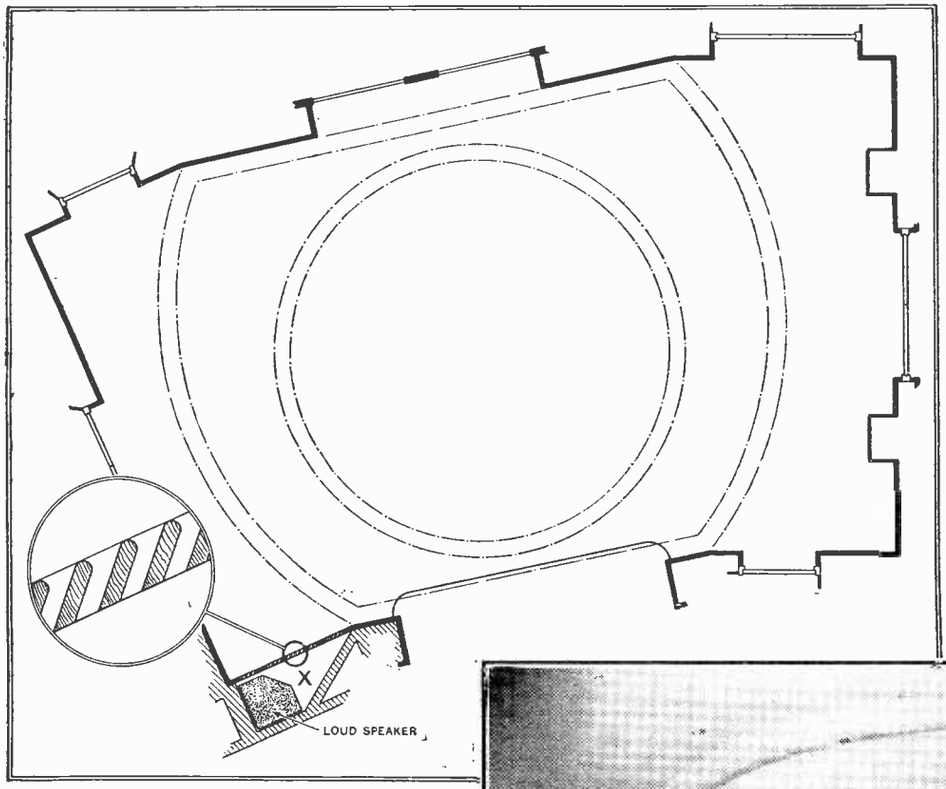

Fig. 7.—Plan of buffet showing position of concealed speaker. The arrangement of the vertical louvres in the panelling is shown in the inset.

As regards the concealment of the horns, this was successfully accomplished by arranging for a part of the ceiling above the stage to be inclined (see Fig. 4), and in the triangular space behind this surface there is ample room for the horns. As the horns are rather long in this case, an opening has been left in the wall. The small end of the horn and the unit is supported in this opening and protected by a cupboard through which it can be examined.

The inclined ceiling was made sound-transparent by the use of cinema sound screen. The material chosen consisted of thin treated metal perforated with small holes about $\frac{1}{4}$in. apart. The holes being small and the material white made it possible to match the plaster fairly closely, and, in fact, unless the light was strong, it was not easy to see which was plaster and which was not. However, the difference *was* noticeable, and it looked as if a coat of paint would just put things right.

The way in which sound travels through cinema-screen material is interesting. Fig. 5 shows a section of the material and a group of lines representing sound waves. As the wave reaches the screen the air which finds the holes flows through, while that which strikes the material in between is stopped and therefore compressed slightly. The pressure produced is sufficient to make it find any opening situated within a fraction of a wavelength and go through. The air on getting through spreads in all directions owing to its pressure, and on meeting corresponding "pressure bubbles" from the other holes joins up with them to travel onward with a plane wavefront once more. So long as the loss of energy due to reflection, the deflection of the air particles, friction in the hole and eddies on reforming remain negligible, the sound will be transmitted effectively.

But when an over-zealous painter fills up the holes with paint! and that is what happened. On test it was found that a good imitation of a conversation going on in the next room could be obtained, but this was not "high quality" as intended.

After lengthy discussion the matter was dealt with architecturally by pricking out part of the sound screen holes to a rectangular shape on the same horizontal level as the motif; and partly, since the horn opening was still largely obstructed, by electrical means which attenuated the base relative to the top. The difference in shading is very slight and will escape notice in the photograph.

The sloping ceiling is arranged so as to make an excellent reflector giving a short path echo which reinforces the natural voice. Further, the general acoustic design of the theatre is so excellent that for the purpose of speech reinforcement the equipment hardly seems justified. Apart from this purpose, however, the speakers are wired so that speeches given in the dining hall or by wireless can be relayed. Also, if the hall is used for "talkie" films, speakers are ready wired and of much better type than those usually used with portable talkie equipment.

The dance band crooner (the theatre has a dance floor) also has discovered some of the possibilities of the equipment, and his reactions on crooning through a high-quality chain for the first time in his life were quite amusing.

Fig. 6 shows a view of the stage and its ceiling, and it will be noted that the fact that it serves an unusual purpose is not apparent.

The third case hardly deserves to be included with PA, since it relates to reproduction pure and simple. This is the buffet or snack bar. The requirements here were to hear speeches either from

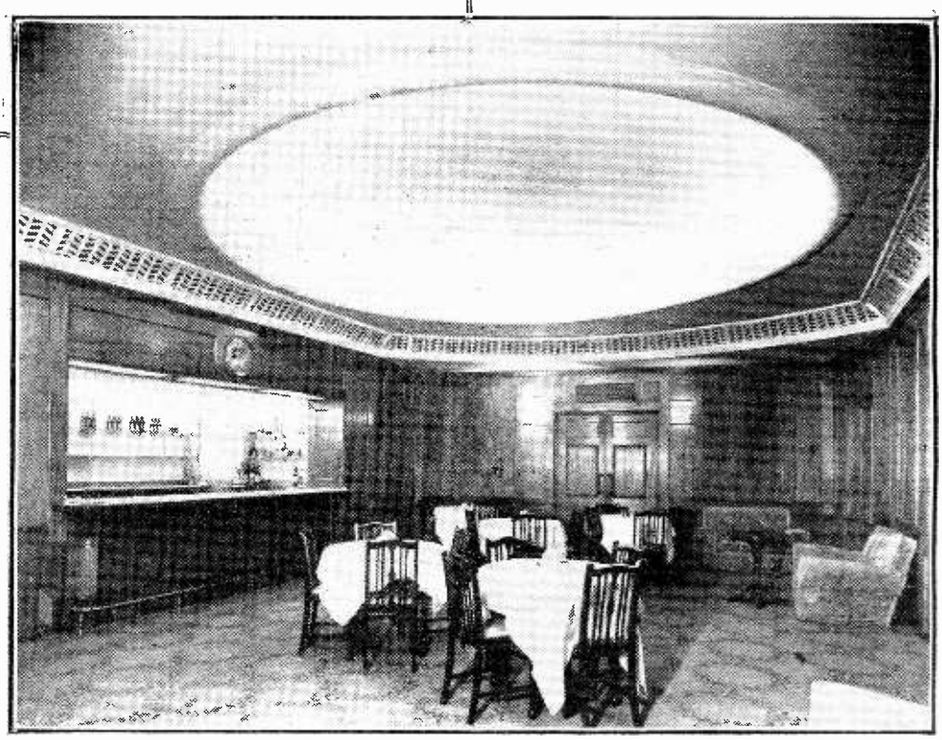

Fig. 8.—Uniform sound distribution makes the location of the concealed loud speaker in the buffet still more difficult for a person entering the room for the first time.

[2] The reasons for this practice are discussed in the article previously referred to.

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Collaborating with the Architect—

the dining hall or the theatre (or music from the latter) and wireless. The room is shaped as shown in Fig. 7, and by "collaboration with the architect" the space X was altered and shaped so as to house a speaker giving a 90 degree distribution.

In this corner the solid panels are replaced by *vertical* louvres at 45 degrees to the surface. These succeed in hiding the loud speaker completely without affecting the sound, while the uniform distribution causes the echoes to be practically as loud as the original sound, and at first make it difficult to tell, even by listening, exactly where the source of sound is situated.

Fig. 8 shows a photo of the buffet, and it will be seen that whilst nothing has detracted from the appearance of the panelling, the source of sound is effectively concealed and performs its function as unobtrusively as the lighting.

RANDOM RADIATIONS

By "DIALLIST"

Blaming the Set

CURIOUS how ready people are to blame the receiving set when reception is spoilt by interference! Some time ago a friend asked me to recommend him a receiver and, having ascertained what he was prepared to pay for it, I did so to the best of my ability. When next I met him he told me that he had bought the set and wished he hadn't. It was no good. Nothing but crackles all the time, though other people in the neighbourhood had no such complaints to make. "Are you sure," I asked, "that the lighting and power circuits of your house are in good order?" "Funny that you should mention that," said he; "I've found that my meter goes on ticking up current even when everything is switched off. Not much, you know. Nothing really to worry about." With some trouble I managed to convince him (a) that it was something to worry about, and (b) that it explained why the set was noisy.

In Old Houses

I sometimes wonder what the electric circuits of some of the older houses must be like and whether their decrepitude isn't responsible for quite a bit of the interference with radio reception that is complained of. Thirty years or so ago the standards and methods of domestic wiring were not quite what they are to-day. If rubber was the main insulation when the wiring was put in years ago, it's probably not exactly in first-rate condition now! At any rate, if your wiring is old and you do suffer from noisiness it may pay to have the household circuits properly tested. The instance mentioned in the preceding paragraph isn't the only one I've come across in which a householder had a surprise when he got a report on a test made of his circuits.

A Present from Uncle Sam

THE United States is being very kind to us in the matter of directional aerials for its short-wave transmitting stations. The Schenectady twins, W2XAF and W2XAD, have them already, to our great content; and now it is announced that W3XAL is to install aerials of the very latest and most efficient type directed towards this country for both its 49.18-metre transmissions and those made on 16.87 metres. An increase of something like six times in the field strength here is predicted, and if that does happen we should have astonishing reception. Both of the W3XAL transmissions from Boundbrook have 35 kilowatts behind them, and they don't do too badly as it is. A large increase in the field strength should mean far less fading at the receiving end, since it gives automatic volume control so much more to play with.

What's the Transmitter?

I expect you've noticed that when the B.B.C. is "taking" a broadcast from the United States you often find a very powerfully received signal on the 19-metre waveband. The announcer generally says, "This is Radio City, New York. America calling Europe," or something of that kind. He doesn't say what the actual transmitting station is. Does any reader know, for certain? Is it W2XAD working with temporarily increased power? Or is some special directional aerial brought into use on these occasions? I have heard the station, when the London transmission was ended, go over to "monitoring" duty, still with the same very big signal strength. Anyhow, it furnishes magnificent reception, and if W3XAL with its new directional aerials is to be in the same class, there won't be much difficulty about hearing the voice of America at full loud speaker strength when we feel the urge to do so.

And Now the Medicos!

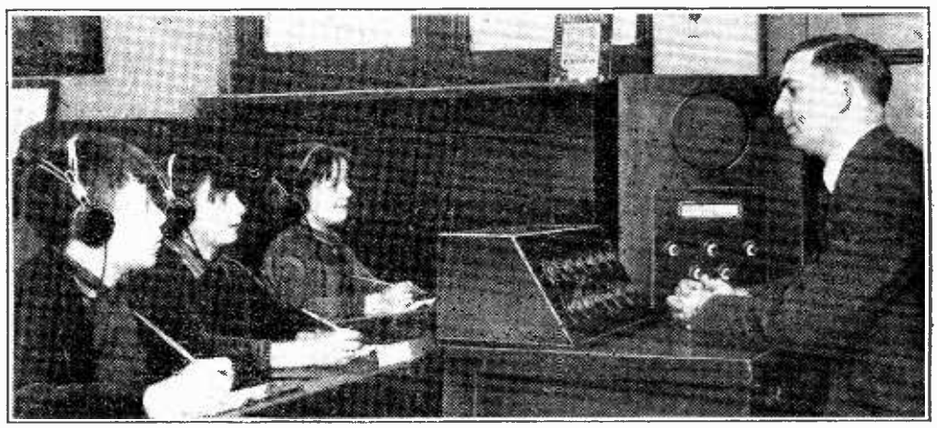
IF you asked your medical man: "Do you think I've really cracked three ribs?" and received the reply: "I can't tell you definitely until I've examined your radiogram," you might wonder for an instant whether it would not be advisable to have a second opinion from one who was less of a wireless enthusiast! But he would be using, for all that, a perfectly correct medical term. When I raised, in these notes, the question: "What is a Radiogram?" I had no idea that claims to the word's ownership had been staked long before there were wireless telegrams or combinations of wireless sets and gramophones. But correspondence in *The Lancet* shows that forty odd years ago a radiogram meant an X-ray photograph, and that it has continued to have this connotation. Realising that "radiogram" has been reft from them by wireless folk, the doctors feel that they must find another word. But what word? They say that "radiograph" is already in use with quite a different meaning.

No Help from America

Once again the crisp, snappy language of the United States fails to live up to its reputation. You may remember that we discovered that what *we* call a radiogram is a radio-phonograph over there. Well, what *doctors* call a radiogram is neither more nor less than a Röntgenogram in the States. I'm all in favour of perpetuating the names of the men who did big things in the development of electricity and wireless by fitting them into technical terms. Luckily, most of them—Volta, Ampère, Ohm, Bell, Gauss, Watt, and so on—had names that were adaptable; but Röntgen just doesn't seem to fall into line. You might lop off the last syllable, as we do with Faraday; but somehow neither Röntgram nor Röntgraph is attractive. I myself can't see very much wrong with X-ray photograph. Or, if that's too long, why not X-radiograph?

The Television Vans

WHAT with the co-axial cable that is being laid round inner London and the fleet of three transmitting vans that the B.B.C. has ordered, the success of the televising of Coronation scenes seems already assured. It seems, though, rather an instance of the irony of fate that the only people who will be able to receive the transmissions are those who live in or near London, and are therefore best able to go out and see the procession for themselves. But life is apt to be like that! We may be sure that the television transmitting vans won't be used just for the Coronation only. With them at his beck and call, Cecil Lewis's successor should have little difficulty in finding all sorts of interesting programme material day in, day out. "In Town To-day" may become as firm a favourite in the daily television programme as "In Town To-night" is in the Saturday evening "sound" transmission.



Multiple channel deaf aid system in use at the Hugh Middleton School for deaf and dumb children. The class is for partially deaf subjects and the teacher is able to control the volume and response independently for each pupil.

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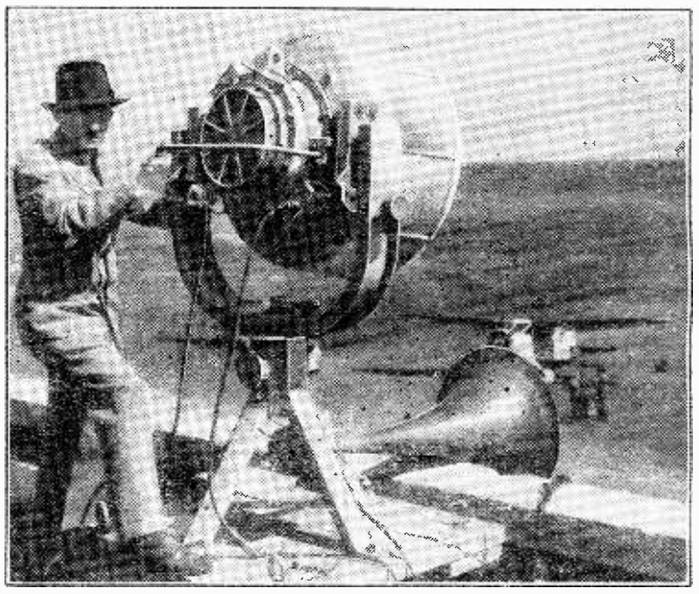
Addressing the American Public

SOUND AMPLIFICATION ON THE GRAND SCALE : RECENT DEVELOPMENTS

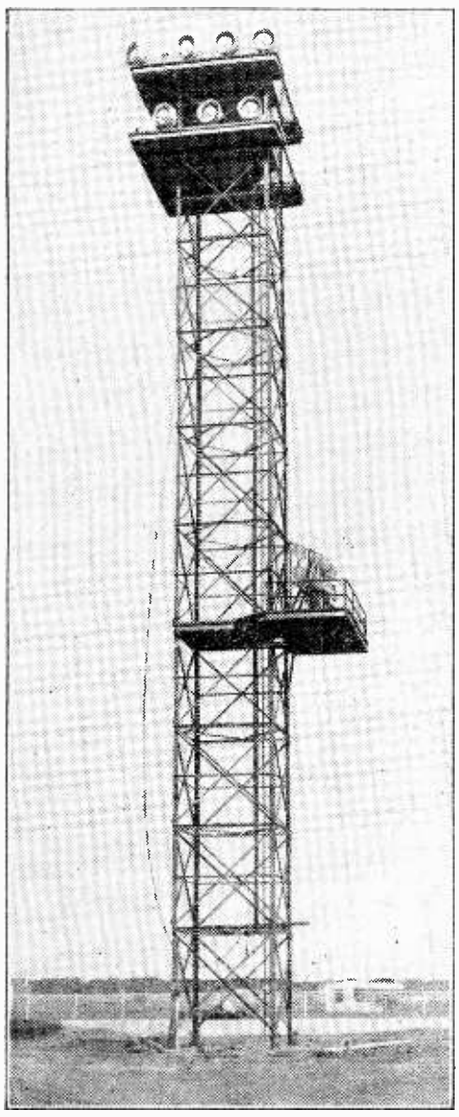
By Our New York Correspondent

THE outstanding achievement of last year by PA engineers on this side of the water was the installation of sound-amplifying equipment at the Roosevelt Raceway for the Vanderbilt Cup motor races. An area of about one square mile was covered, including miles of stands, some 50,000 parked cars, with about 100,000 persons. Above all, there was the roar of many high-powered racing cars to contend with.

This notable feat was accomplished by the Bell Telephone Laboratories and the Western Electric Co. A survey was first made, indicating the noise level at different points. Next, one of the 1-kilowatt "bull horns" first described in connection with the last America's Cup yacht race, was set up and sound measurements made at various points around the track. These preliminary measurements indicated that approximately 10 kW of acoustic power would be necessary. As the speakers to be used were approximately 50 per cent. efficient, this part of the problem was solved by providing 20 amplifiers of 1 kW each.



An engineer of the Western Electric Company shows how the super-power sound projector may be trained upon a distant "target" so that voice or music may be delivered to that point without wasting acoustic energy over a large area



A hundred-foot steel tower carrying a 20-kilowatt group of loud speakers installed at Roosevelt Raceway, Long Island. The sound projectors on the two platforms at the top project sound beams to cover remote portions of the course, while the smaller loud speakers on the lower platform serve the nearby grandstand and paddock.

Another innovation was the centralisation of the speakers in one group—mounted at two levels near the top of a 100ft. steel tower—focused at the several points where the greatest number of spectators would congregate. Twelve additional units, handling 100 watts each, were mounted on the same tower, about 20 feet above the ground, and trained on the adjacent grandstands. This centralisation of power eliminated confusing echoes that would be brought about if a number of units were scattered about the track. The success of this unusual system was in large measure due to the directional characteristics of the large horns. These units could be focused to serve a point half a mile distant from the grandstand directly underneath them, and yet no appreciable sound would be heard nearby. While such a system may not be feasible for PA work in general, there is little doubt that more use will be made in the future of this principle of "focused sound."

Next in importance was the stereophonic installation made at the Hollywood Bowl, California, where the three-dimensional reproducing system developed by the Bell Telephone Laboratories was used to reinforce Leopold Stokowski's orchestra of 120 players during its performances before 15,000 people in that great natural amphitheatre. Due to the size of the bowl and to the entire absence of reverberation, some 5 kW was required for this job. Very large low-frequency dynamic speaker units of the direct radiator type were used in conjunction with massive folded horns. A large "tweeter" of the diaphragm type working into a multi-section cellular horn was employed to handle frequencies from 300 to 10,000 c/s. As is common with well-designed horn-loaded units, the efficiency of this combination was approximately 50 per cent., while the measured frequency response as measured in the bowl varied less than 5 db. between 50 and 10,000 c/s.

"Stereophonic" Hearing

To give the illusion of naturalness, and taking into account the binaural human sense of hearing, three channels were used, each with its separate microphone; one in the centre, one on the left, and the third on the right of the orchestra. These three microphones were followed by individual amplifiers terminating in three individual pairs of speakers located in the same relative position with respect to the audience as the microphones. By means of this complete three-channel system the listener is able to locate any sound source with respect to its position before the microphones.

A great incentive to PA engineers was provided by the Presidential election,

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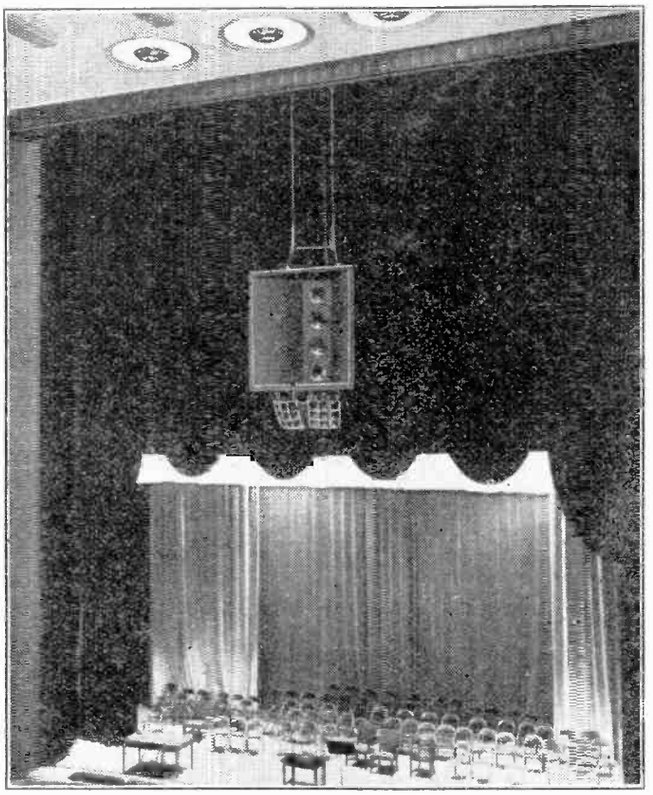
during which every kind of equipment was brought into use, from the small portable amplifier of the street-corner orator to the highly developed system employed by the Republican National Committee, which provided "outputs" for broadcasting and news-reel cameras, as well as sound reinforcement for the audience.

Another PA installation of great interest is that supplied to the Kansas City Auditorium by the Western Electric Company. The requirements were that the main arena (with a seating capacity of 13,000 persons and a cubic content of 4.5 million cubic feet) should be covered uniformly, and with freedom from echo and time-lag effects. Also, this system was to provide distortionless reproduction of both speech and music; both frequency response and volume range were to be of equal importance. The method finally decided upon depended, first of all, on a central loud-speaker installation capable of covering the auditorium uniformly. This "projectolier," as it was named, consisted of a group of high- and low-frequency dynamic units suspended from the ceiling. To drive these units an amplifier with an undistorted output of 300 watts was employed. On important occasions—such as the recent visit by President Roosevelt—packed audiences were able to hear every word in every part of the hall.



View from the balcony looking towards the stage of the music hall, showing one of the units in the Kansas City Auditorium group. The "projectolier" may be seen suspended directly over the centre of the stage.

Also, this auditorium contained a 3,000-seat music hall with a similar installation; a tremendous exhibition hall, a little theatre and several "committee rooms." This installation was so complete and flexible that speech, "live" or recorded music, and radio programmes could be reproduced in all of these many halls—or each of them could have an individual programme of speech or music. Also, the two theatres are equipped with the latest Western Electric Mirrophonic Sound picture equipment. All in all, it is perhaps the most complete installation in this country.

As already implied, the use of PA in America is ever increasing, both for conventional and unconventional purposes. Equipment now being manufactured is of much higher quality than that of even a year ago. A typical AC-operated amplifier now available can deliver over 60 watts with little more than 5 per cent. distortion; the gain is more than 140 db. Such an instrument is housed in the space formerly required for a 10-watt amplifier. This equipment will stand up to much more abuse than earlier units.

Speakers have a much wider frequency response, greater efficiency, and are more or less proof against the elements. The up-to-date PA man uses velocity, moving-coil and crystal microphones.

One of our most recent amplifiers includes a cathode-ray indicator which permits the operation of the system at the threshold of "singing."

The new Kansas City Auditorium, filled to capacity during the recent visit of President Roosevelt, who appears on the speaker's rostrum. The centrally located sound "projectolier" may be seen suspended from the ceiling.

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CURRENT TOPICS

Radio Societies Booming

ALTHOUGH many listeners are inclined to think that the heyday of wireless societies is past, this is by no means the case, as is shown by the steadily increasing membership figures of many societies. As an illustration of this fact it may be mentioned that on December 1st the Radio Society of Great Britain had 3,046 members as compared with 2,587 in 1935 and 1,537 way back in 1931. The increase is to a large extent explained by the increasing interest in short-wave reception.

British Amateur Statistics

A RECENT check on the activities of amateur transmitter stations which was made by members of the Radio Society of Great Britain has brought to light the fact that no fewer than 75 per cent. of licensed transmitters are regularly active This check has also revealed the fact that the 42-metre band is by far the most popular. Over 900 different British amateur stations were heard on this band during November last. The 21-metre band came next with 487 stations. The longer wavebands seemed to be far less popular, as in the case of the 84-metre band only 123 stations were heard, and 148 stations on the 160-metre.

Call Sign Proposals

IT is understood that the G.P.O. intend to follow the example of the U.S.A. in allotting call letters to experimental stations. In that country after the preliminary prefix W there follows a numeral and then the letters X, Y or Z, which is again followed by letters identifying the particular station concerned. Well-known examples are W1XAL and W2XAD. It is understood that the G.P.O. will allot call signs in the group from G8YA to G8ZZ.

World's Smallest Transmitter?

THE small portable transmitter-receiver is becoming increasingly popular. At the recent Norwegian radio exhibition what was claimed to be the smallest specimen of these devices was on show. It is reported to be sufficiently compact to be slipped into the pocket quite comfortably. If this be the case it must be as small as, or even smaller than, many of the midget headphone sets which were shown at Olympia last year. The designer is Mr. Holth, a well-known Norwegian radio engineer.

Swedish Listeners

DURING the last three months of 1936 nearly 30,000 new listeners were registered in Sweden. The total number of listeners at the end of December was 945,000, which is equivalent to rather more than 15 per cent. of the population.

Wireless Medical Services

IN certain of the more remote Russian villages medical attention is not at all easy to obtain in the case of sudden illness. In many cases ordinary telegraphic communication with these villages is frequently interrupted.

The U.S.S.R. authorities are therefore providing automatic wireless transmitters which can be set into action by an unskilled person for the purpose of summoning medical aid from the nearest available point. Aeroplanes are also being provided to convey doctors and nurses to their destination as quickly as possible. As in many cases there is no landing ground available near these villages, specially picked doctors and nurses are being trained in the use of parachutes. It is not stated how they will return to civilisation.

C.B.S. Jamboree Plans

HARDLY have the tenth anniversary celebrations of the N.B.C. come to an end than it is announced that the rival Columbia organisation is planning great things for its own tenth birthday in the autumn. Already many famous artistes have been engaged.

STAND CLEAR OF THE DOORS. Public address equipment is being employed more and more by the London Passenger Transport Board to make easier the task of controlling the millions of passengers carried on the Underground system. These "Wireless World" photographs show one of the latest types of lifts now being installed at the Goodge Street Underground Station. By means of loud speakers passengers are warned to "Stand Clear of the Doors" before these are automatically operated. The system employs an amplifier and a photo cell fed from a controlled sound track on a continuous belt of film, illuminated by a 12-volt lamp. A spare lamp automatically comes into operation should the original one burn out.

Malaya Calling

FOLLOWING the formation of the British Malayan Broadcasting Co. the Federated Malay States will shortly possess a regular broadcast service, a station being opened, it is expected, near Singapore. Kuala Lumpur may—for a time, at any rate—still have to rely on "unofficial" broadcasting as it has done in the past. Malaya has 7,000 licensed listeners out of a population of over 4,000,000.

EVENTS OF THE WEEK IN BRIEF REVIEW

The licence fee costs the equivalent of about 30s.

P.O. Chief in Honours List

A KNIGHTHOOD has been conferred on Lt.-Col. A. G. Lee, O.B.E., M.C., B.Sc., M.I.E.E., Engineer-in-Chief of the Post Office. Colonel Lee played a prominent part in the development of the Rugby station and of international radio-telephony. He has represented this country at many international conferences, is Chairman of the Radio Research Board, and in 1929 was elected Vice-President of the American I.R.E.

Amateurs to the Rescue

ONCE more a time of national emergency has shown how invaluable are the amateur transmitters. During the recent disastrous floods in the U.S.A., when telephone and telegraph wires were swept away, amateurs, as they did on a previous occasion, formed the only link between certain isolated areas and the outside world.

Chimney-pot Aerials

ALTHOUGH one-mast aerials in the shape of di-poles are now rapidly coming to the fore, it must not be forgotten that one-mast aerials have been popular for many years in this country, and they have usually been fixed to chimney-pots or to brackets attached to window frames. Apparently progress is not so marked on the Continent, however, as considerable publicity is being given to the fact that one of these aerials—hailed as a new type—is to be exhibited at the famous Leipzig Spring Fair, which this year is being held from February 28th to March 8th.

Pigeons and Wireless

TROUBLE is brewing in parts of Northern France owing to the steadily increasing number of wireless aerials. This region abounds in pigeon fanciers, and a large number of birds are constantly getting killed owing to their flying into the aerial wires. As a result, an official request has been sent to listeners in certain districts to protect the birds by putting corks or other visible objects on the wires.

The lists of short-, medium- and long-wave stations that usually appear in the first issue of each month are unavoidably held over till next week.

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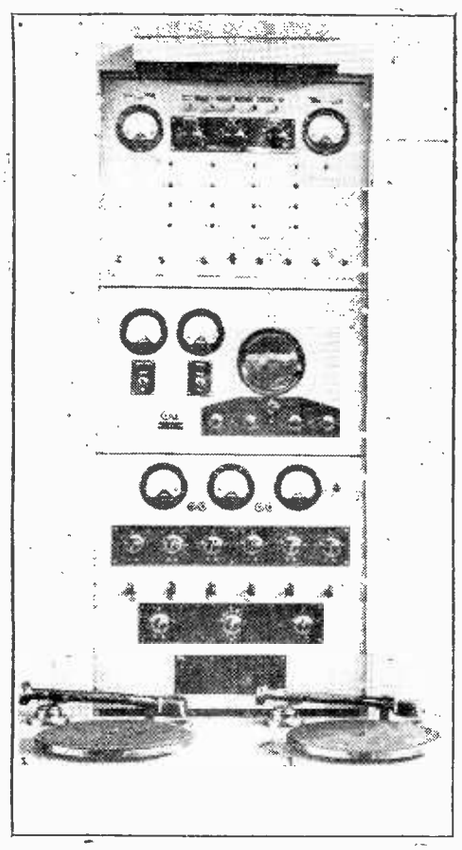
Public Address Equipment

A REVIEW OF CURRENT APPARATUS

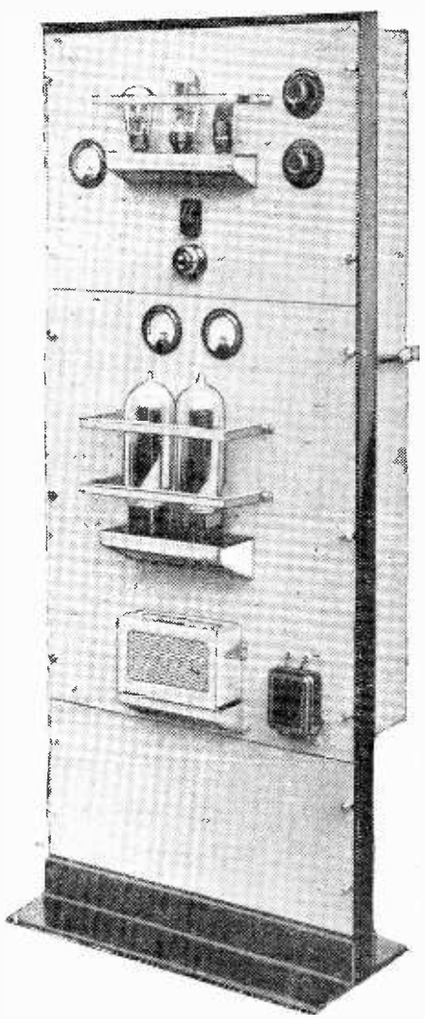
IN bygone days whenever a public function of any consequence was held only a few of those present were in a position to hear any speeches or announcements that might be made, and as a consequence much of the interest was lost to those not favourably situated. To-day, however, it is rare indeed for anyone attending such functions to find himself in a position where only a visual picture is possible; indeed, it is not uncommon for one to be able to follow a verbal description yet not even catch a fleeting glimpse of what is happening.

The now widespread use of sound broadcasting, or if you prefer, public address, equipment has brought about these changes and made it so much easier to enjoy to the full the fare provided.

Apart from the telephone we do not perhaps fully realise the important part played by the ubiquitous microphone and its associated apparatus in our daily lives. A cinema performance would be a dull affair to-day without the sound accompaniment, a lecture in a large hall would lose much of its interest to those remote from the platform, and what would an affair like the Air Force Display be now without the loud speakers giving a vivid description of the aerobatics and other pertinent matter?

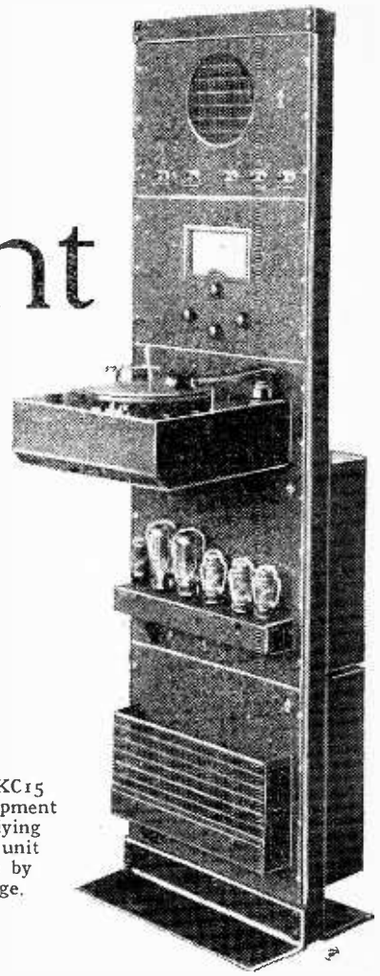


Marconiphone PA equipment fitted with dual turntables.



Parmeko 90-watt amplifier.

Though it would be possible to call forth example after example of the way in which sound amplification and diffusion comes to our aid, it is of more interest to give a thought to the apparatus itself that performs this useful service, especially so since only the beginning and the end of the chain, namely, microphone and loud speaker, are visible as a rule the remainder being tucked away in some convenient corner or contained within an inconspicuous motor van.



Type KC15 PA equipment embodying radio unit made by Savage.

Amplifying equipment can be divided broadly into two classes, portable and fixed installations. Though in the first category could be included any amplifier that is capable of being moved, in actual fact the demarkation is much more obvious as the various manufacturers make a point of assembling their portable equipment in easily handled cases or in some other convenient form.

The majority of the firms engaged in PA work make both types, and it is now almost universal to adopt what is described as P.O. rack assembly for the fixed installations, the expression being adopted since the method of construction bears a marked resemblance to the racks used in telephone exchanges. This form of construction is, of course, very elastic, and practically any type of amplifier with mixing panels, gramophone turntable, and even a radio unit can be assembled from standard units in a very short time.

Rack-built amplifiers of this type are found among the Marconiphone PA equipment. Its construction is such that any combination of some twelve different standard units can be embodied in a single assembly. Single or double turntable units can be included, also a radio chassis.

Where future requirements cannot be foreseen the rack assembly can always be augmented by the addition of extra units, provided all the available space is not already occupied. This will rarely be the case, for the standard height of the Marconiphone framework is about 6ft. 6in.,

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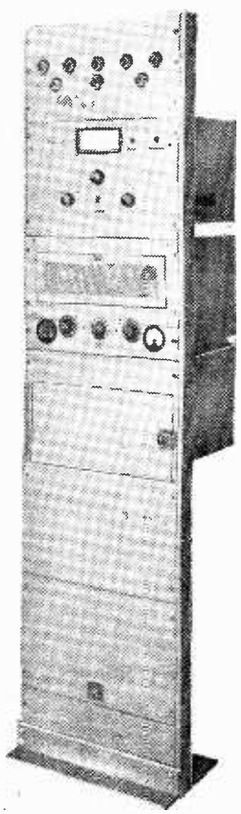
though this could always be exceeded in special cases should the need arise.

The Parmeko 90-watt amplifier, Type A.90, is another example of rack assembly designed primarily for permanent installations. It will operate up to 200 loud speakers of normal domestic size, and when fitted with a radio unit makes a suitable installation for hospitals and hotels, etc.

The amplifying equipment is divided into two parts, one a voltage amplifier consisting of three stages terminating in a PX25 valve, and an output unit in which two DA100 valves are fitted. W. Bryan Savage also makes equipment of this style, one model being the KC15, comprising a monitor LS panel with output line switches, two 30-watt low-loading amplifier units, a record changer panel and a radio chassis.

Though this is an assembly that would meet many requirements like all rack-built amplifiers its make-up is very elastic, and any of the panels could easily be replaced by others so that the example described is very much in the nature of a specimen assembly subject to any modifications that may be needed to fulfil the actual requirements for which the installation is needed.

Since in the majority of cases permanent installations of this kind are built for a specific purpose, many of the firms that make them are not in a position to give precise details as a standard arrangement does not exist. Some, like those already mentioned, have a number of standard units designed for embodying in rack assemblies where the requirements can be met by such units, but more often than not the various panels may have to be built for the purpose.



Rack amplifier built by B.T.H.

It may not be certain that this applies to the Tannoy rack equipment, but the fact remains that no details of standard rack panels have been sent to us; yet rack assemblies built by this firm have been examined from time to time, though generally the apparatus has been described as a special installation made to order.

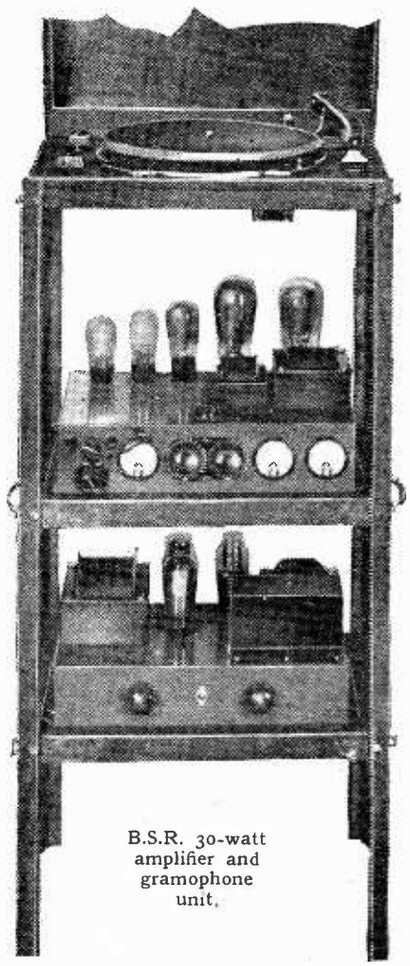
Film industries also build their large equipment only to special order.

The G.E.C. also adopt the rack-mounting system for their large installations, and there are quite a number of standard units, described as subsidiary panels, for incorporation in the assembly. A two-stage microphone pre-amplifier is one, another is a turntable unit while there are several distribution and control panels available.

A comparatively new addition to the equipment is a 100-watt power-output panel consisting of a three-stage amplifier with an output stage comprising four Osram DA30 valves arranged in parallel push-pull. An input of 0.28 volt will fully load this amplifier.

A series of units assembled on panels for rack mounting form the nucleus of the Dynatron PA equipment made by H. Hacker and Sons.

Though power amplifiers giving up to 45 watts output are available, this firm often adopts the practice of fitting several 12-watt push-pull units arranged in banks to feed various loud-speaker systems. Radio tuners, pre-amplifiers, gramophone units and mixing panels are also available for assembling into a complete installation in rack form. The LF512R 12-watt amplifier has a total of five valves and requires 0.3 volt input to fully load the output stage.

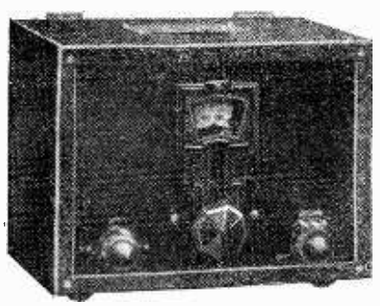


B.S.R. 30-watt amplifier and gramophone unit.

The British Thomson-Houston Company make a speciality of the larger type of public address installations all of which are, of course, designed for the particular work they have to perform. Many other firms could also be mentioned, but the few examples given here must suffice to illustrate the type of amplifying equipment that falls within this category. It is of interest to the radio and acoustic engineer, but for those who have dealings with the more usual demands for PA equipment the smaller apparatus capable of being taken from place to place and installed for a lecture, a sports meeting and for similar purposes is, perhaps, the more important.

The equipment that may be considered under this heading is usually built in convenient-sized cases arranged for easy transportation, though most of the firms interested in its construction also make the amplifier in chassis form, leaving the user to assemble the various parts in a way best suited to his particular requirements.

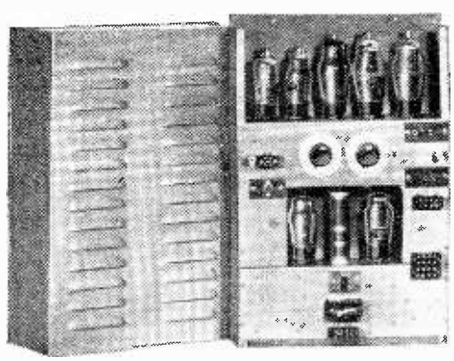
Amplifier of the Ardente "Coronation" PA equipment and (below) its radio unit.



Armstrong Manufacturing Co. supply a 10-watt amplifier, 6-valve circuit, using two large triodes in push-pull for the output. This amplifier is fitted with two independent fader controls that enable speech to be superimposed on music, or vice versa. The price is £9 9s. This amplifier can be supplied as complete equipment fitted in massive walnut cabinet with automatic record changer, including pick-up. It plays all sizes of records mixed in any order without pre-setting. A microphone and stand, also two PM loud speakers, are included, and the price of the complete installation is 50 guineas.

Ardente has introduced for use this year a "Coronation" PA outfit which can be operated by non-technical people and is designed to be quickly assembled and dismantled.

It consists of a combined amplifier and gramophone turntable as one unit, to which



Wall-mounting amplifier made by Correx.

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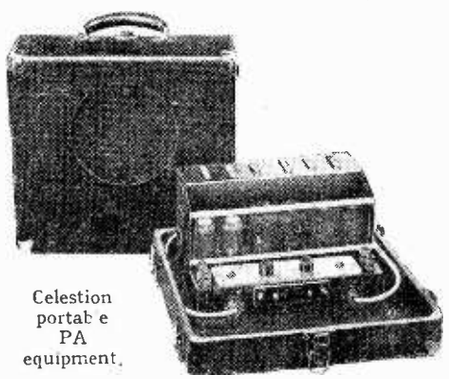
can be added a radio tuner unit. A moving-coil microphone and a PM loud speaker in a directional baffle are included. The equipment is AC operated and can be supplied in three types giving 10, 15 and 20 watts undistorted power output.

The radio unit has an RF stage followed by an anode bend detector, the output being fed into the main amplifier by a multi-way cable which provides the operating voltages for the unit. It covers both broadcast wavebands. The price of the complete outfit depends on the output required, and this is conveniently stated not in watts but in the number of people it is desired to address. Up to 2,000 persons one loud speaker suffices, whereas for 12,000 the makers recommend six loud speakers. The first-mentioned costs £55, AC operated, or £65 AC/DC operated, while the last-mentioned is priced at £95 for an AC model.

The mobile amplifying equipment made by Birmingham Sound Reproducers is especially interesting in that it can be operated either from AC mains or from a 12-volt car battery. It is rated at 12 watts undistorted output and is built into a massive case fitted with carrying handles and includes also a gramophone motor.

A four-stage amplifier is used, the first two valves being resistance-capacity coupled



Celestion portable PA equipment.

followed by a driver stage transformer-coupled to two PP3/250 valves in push-pull. There is also an HT valve rectifier. A multi-ratio output transformer is fitted to enable matching for one or for a bank of loud speakers. Incorporated in the case is a rotary transformer for battery operation.

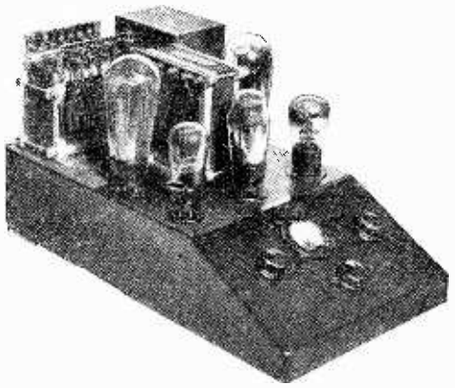
In addition B.S.R. have a long range of chassis-built models in various sizes, all of which have a sufficiently high gain to enable a microphone to be used without a pre-amplifier.

The Correx series of PA amplifiers is a particularly comprehensive one and contains models for AC/DC, battery and AC operation. The AC/DC and battery models are undergoing complete redesign, but details are available of the AC type. The four principal models are the S10, S20, S45 and S60 with power output ratings of 7, 14, 45 and 60 watts respectively.

In all these models the input circuits are similar and provision is made for two microphones, one radio input and one gramophone input, all at 600 ohms impedance. The output circuits of the associated units are consequently matched to this impedance for connection to the main amplifier.

The S45 model has two resistance-capacity coupled stages followed by a transformer-coupled driver stage to two DA30 valves in push-pull. This model has an overall gain of 110 db., which is increased to 135 db. by the addition of a pre-amplifier and complete with mixing and fading control panel costs 60 guineas.

The S10 is a two-stage model with one PX25 valve giving 7 watts, and its price is 18 guineas. These prices include a stout steel case.



Coulphone 12-watt amplifier.

Alex Burns makes a small portable amplifier with the loud speaker included in the case which with microphone costs 20 guineas, and Electradix Radios make one also on similar lines for AC/DC operation, and this model with a crystal microphone costs £18.

Portable PA equipment is now being made by Celestion, the amplifier, loud speaker, microphone, stand and cables being assembled in a carrying case measuring 17in. × 16in. × 9in., while in another case of similar size is a gramophone unit.

The Coulphone Radio Manufacturing Co., have a range of inexpensive models some of which are assembled in portable cases and include a gramophone motor. Seven models are available ranging from 4 to 70 watts output, the larger models being for AC operation only. A 12-watt five-valve chassis costs £12.

A number of portable and chassis amplifiers are included in the products of Film Industries, a large section being of the self-contained type, embodying a gramophone turntable. The model 4/20P, which gives 20 watts output, is well suited for many of the

Amplifier and gramophone unit of portable equipment made by Francis, Day and Hunter.

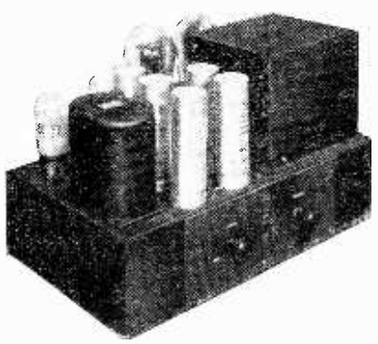
indoor and outdoor requirements of to-day. It is fitted with a three-stage amplifier with two PT25H pentodes in push-pull in the output stage. It is AC operated and costs £52 10s.

The portable public address equipment supplied by Francis Day and Hunter includes, among other models, a compact general-purpose amplifier known as the model AC/DC 12/18. It consists of a three-stage amplifier, gramophone turntable, loud speaker and microphone in transportable form, and for convenience the equipment is contained in two cabinets. Complete, it costs 38 guineas.

The G.E.C. amplifiers that come within this category of medium-power equipment, are the All-Purpose models of which there are two, one being a 6-watt model, while the other is rated at 14 watts output. Both are very compact and entirely self-contained and are operated from AC.

These two units are available in chassis form at £19 16s. for the 6-watt, and £25 10s. for the 12-watt model, and also as transportable amplifiers, in which case the chassis are mounted in stout oak carrying cases. In another form they can be obtained for rack assembly, the amplifier chassis being fitted to a panel.

There is also what is described as the turntable model, and either the 6- or 14-watt chassis can be supplied in this form, which includes in the cabinet a gramophone turntable and pick-up. In this style it costs £31 6s. with the BCS.1582 6-watt chassis, and £37 with the BCS.1587 14-watt chassis.

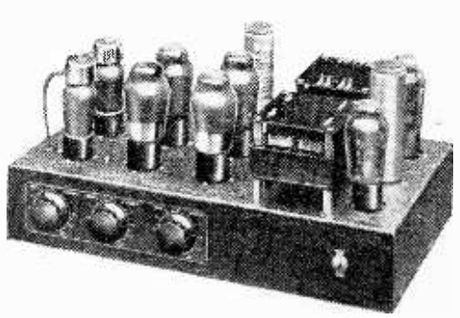


G.E.C. Model BCS.1587 general-purpose amplifier.

Both chassis include power supply equipment and an input transformer for a moving coil microphone and provision is made for microphone, gramophone and radio inputs.

The past few years have seen a growing demand for portable amplifying equipment that can be handled by the non-technical. Apparatus of this type is being used extensively by dance bands and other bodies of entertainers, so consequently it must be comparatively simple to assemble and dismantle.

Several firms make a speciality of this type, prominent among which are Grampian Reproducers. There is an outfit described as The Crooner which comprises a universal amplifier giving 6½ watts output. A moving-coil microphone is included, and the price is 20 guineas complete with loud speaker and waterproof carrying case.



Grampian 14-watt amplifier chassis.

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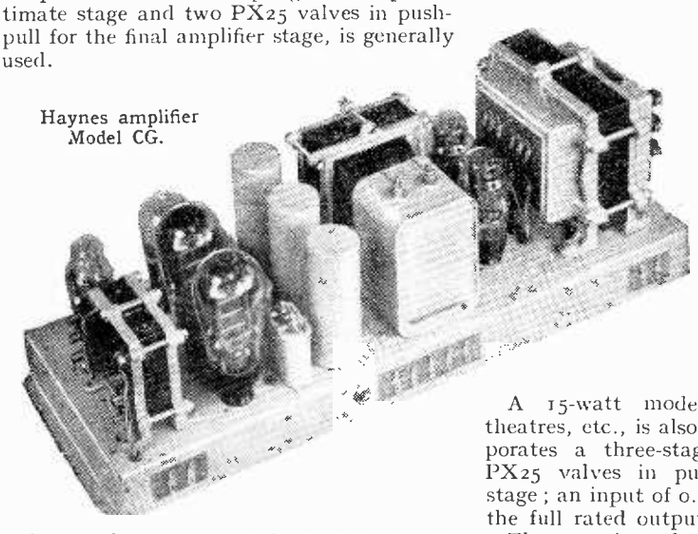
Public Address Equipment—

On the other hand, this firm also cater for those requiring chassis amplifiers for incorporating in PA equipment. One such model is the 14½-watt AC/DC model. It contains two high-gain amplifying stages followed by four output pentodes in parallel push-pull. Microphone and gramophone input controls are fitted, and provision is also made to obtain from the amplifier the polarising voltage for a transverse current carbon microphone. Carbon or moving-coil microphones can be used, and the price is 16 guineas.

There is also a 25-watt amplifier available in which two PT25H type valves are used in push-pull in the output stage. This model costs £45.

For PA work Haynes Radio supply a 14-watt amplifier which forms the basis of the equipment. Slight changes are made in the circuit to suit individual requirements, but the fundamental circuit, which embodies duophase intervalve coupling for the penultimate stage and two PX25 valves in push-pull for the final amplifier stage, is generally used.



Haynes amplifier Model CG.

A general-purpose amplifier built in chassis form and fitted with two PX25 valves giving 14 watts output is made by Hartley Turner Radio, and this model will meet many of the requirements of PA work.

Several units can be assembled in a bank and the output from each arranged to feed one or more loud speakers, but all can be worked off a common input circuit.

The GA12S model, as it is described, is a three-stage unit, the first being resistance-capacity coupled and the second transformer-coupled to the push-pull output valves. An input of 0.07 volt only is required to fully load the amplifier. It costs £13 10s.

Holmer PA equipment is supplied by Holiday and Hemmerdinger, a speciality of this firm being mobile apparatus operated from car batteries. Sets rated at 5 watts are available for installing in private cars or vans at prices of from £18 18s. to £22 complete. This firm also supplies larger equipment and acts as stockists of PA apparatus generally.

In their portable amplifiers M.R. Supplies use two high-efficiency pentodes in push-pull and obtain an output of 7 to 8 watts with one pre-amplifying stage. With the two-stage model a microphone of the transverse current type can be used without any additional amplification.

All the equipment is contained in two portable cases and its price complete with hand microphone is 12 guineas.

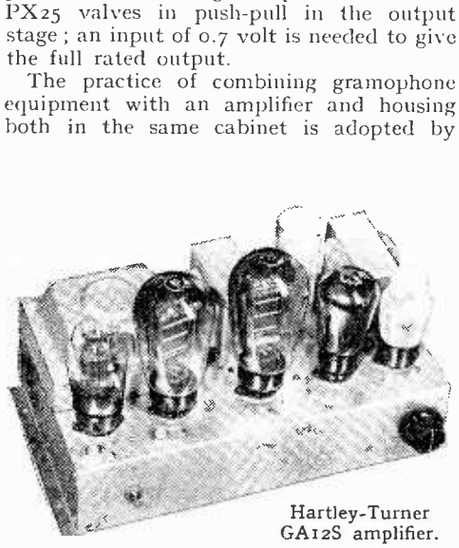
A series of new amplifiers has been produced by Magnaphone, the special feature of which is the high efficiency that is claimed for the output stage. They are known as Bi-Phase Direct Coupled Amplifiers and the P.A. 50 model for example is stated to give an undistorted output of 21 watts with an anode dissipation of 50 watts at the final amplifier. They are AC operated and the model mentioned costs £50 assembled in a transportable case and including two turntables.

A larger model is also available at £100, while there are some low-power self-contained portable models for AC/DC or battery operation at £34, including turntable, microphone and a loud speaker.

Though the Marconiphone Co. makes a speciality of the larger type of PA equipment, self-contained transportable models are also included among their products. One interesting type is the Demonstration Equipment Model E.M.5B. It can be operated entirely from a 12-volt car battery by using a converter, and gives an output of 10 to 11 watts. Gramophone turntable, pick-up and microphone are included, and the whole is assembled in a stout oak carrying case.

A 15-watt model for use in hotels, theatres, etc., is also available. This incorporates a three-stage amplifier with two PX25 valves in push-pull in the output stage; an input of 0.7 volt is needed to give the full rated output.

The practice of combining gramophone equipment with an amplifier and housing both in the same cabinet is adopted by almost every maker of PA apparatus. Some provide two turntables with separate pick-ups with mixing and fading controls.

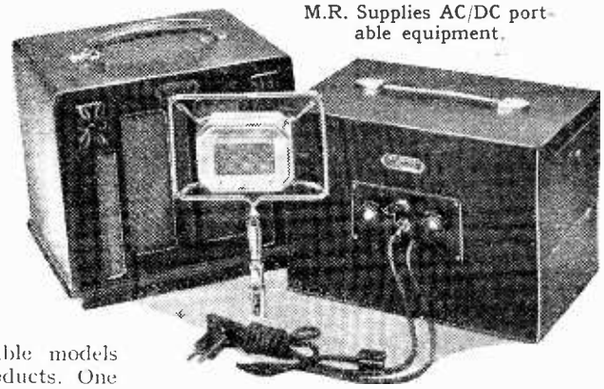


Hartley-Turner GA12S amplifier.

Microphone Equipment have several models of this type; one rated at 25 watts has push-pull output and resistance coupling throughout, with a phase inverting stage. The output stage has four triodes arranged in parallel push-pull. There are nine valves in all.

As a transportable model it is provided with two turntables, microphone and two large PM loud speakers, and the whole is accommodated in two convenient sized cabinets for portability. It costs 65 guineas. Eight or more loud speakers could be used with this model if necessary.

Amplifiers of from 6 to 45 watts output are made by Parmeko in portable and transportable form, though as mentioned earlier this firm also manufacture large power equipment for permanent installations of the rack-type assembly.



M.R. Supplies AC/DC portable equipment.

The Type DBE6 is a compact unit in a portable cabinet and embodies a loud speaker. It has a three-stage amplifier giving 6 watts output and weighs 68lb. A telescopic microphone stand is included, also a transverse current carbon microphone. Operation is from the AC mains and the price is £28.

A 6-watt amplifier chassis with a gramophone turntable but excluding loud speaker and microphone is available also at the same price.

The amplifier is a three-stage unit giving ample gain for direct operation from a microphone. The whole is assembled in a steel carrying case.

One of the portable models, the Type C.30, is particularly compact considering the large power output it provides. Though rated at 30 watts output the amplifier chassis and turntable are accommodated in a carrying case measuring 23in. by 16in. by 17in. This is a four-stage unit with two RC-coupled amplifiers followed by one transformer-coupled driver stage for two PX25A valves working in low loading push-pull. The price of this model is £48.

One of the simplest forms of PA apparatus is made by Philips. It is known as the Voxmobile car-amplifier and it has been designed for building into motor cars. A single valve amplifier is used and the unit is intended for microphone announcenients only. The total consumption is 30 watts. Various styles of small and large amplifiers are made by this firm. Some are for car installation and designed for operation from batteries, while some are of more orthodox pattern.

There is one 10-watt model for AC/DC or battery operation. Its total consumption is about 84 watts when battery operated. High-gain pre-amplification is obtained by

Philips Type 3762 AC/DC 10-watt amplifier.

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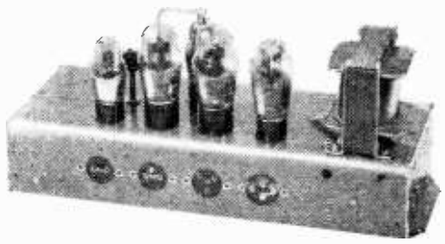
using RF pentodes in push-pull, while the output stage has four P13 valves in parallel push-pull.

Frequency correction circuits are embodied, and, on changing over from microphone to gramophone correction circuits suitable for the different styles of input are automatically included. Philips make also a long range of larger amplifiers and a small radio unit for connecting to any of their models.

Premier Supply Stores have developed a 7-watt universal amplifier for use on AC or DC supplies. American valves are used throughout in a three-stage circuit which consists of an RC-coupled stage feeding two Type 18 pentodes in push-pull. This model costs 5 guineas complete with valves.

Equally interesting is a small two-stage model also fitted with American valves and



Premier Supply Stores 7-watt amplifier.

costing £2 15s. complete. Both these amplifiers can be obtained as kits of parts for home assembly.

R. A. Rothermel is introducing for this year an entirely new range of American-made amplifiers. Eight or nine different models will soon be available, and they range in size from 7 to 60 watts output.

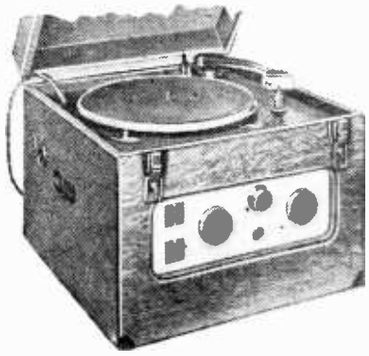
One of the most interesting of this new series is the Type MP-420 mobile model, which has a rated output of 20 watts. It embodies a 4-stage amplifier and a universal electric gramophone motor. The special feature of its design is a plug-in-type power pack which can be quickly changed for AC or battery operation. An orthodox rectifying unit serves in the one case, but for battery use this is replaced by a compact rotary converter. The overall amplification is very high, and, like all the new models, it operates direct from a crystal microphone. The price complete is £40.

The 15-watt model of this series contains a 10 valve chassis, but four of these are used

Rothermel mobile PA amplifier and alternative power unit for battery operation

as separate pre-amplifiers for four different input channels, and each has its own volume control. Microphone or gramophone can be joined in any combination to the input channels. There is a master volume control and a tone compensator.

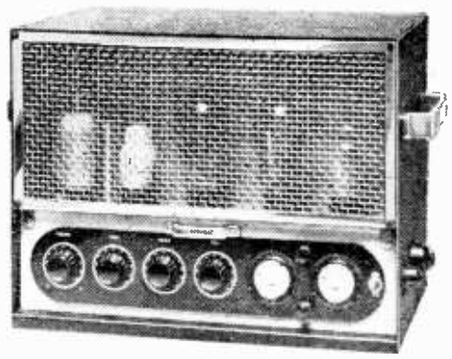
The standard PA equipment made by W. Bryan Savage is supplied in chassis form and as portable models, the latter embodying a gramophone turntable and pick-up. Several different chassis, mainly two- and three-stage, are available, giving power outputs of 8 and 15 watts respectively. Some



Shaftesbury Microphones MM 15 Portable Amplifier, for AC DC and battery operation.

are of much higher gain than others, so that a microphone can be used without additional pre-amplification.

A complete portable amplifier with turntable, etc., costs from £23 10s. to £29 10s.; the former is for an 8-watt model, while the latter is for one giving 22 watts output and is described as the Type 322G. This differs from the majority of Savage amplifiers in that two super-power pentodes are used in push-pull for the output, whereas the remainder of the chassis are fitted with triode output valves.



Sound Sales 14-watt amplifier.

A 12-watt, a 30-watt, and several microphone pre-amplifiers are obtainable from the Scientific Supply Stores. The 30-watt model has three stages, the first RC-coupled and the second transformer-coupled to two PX25A valves in low-loading push-pull. Provision is made for supplying HT and LT to a pre-amplifier. The 30-watt model costs £15 15s., while a two-stage pre-amplifier with provision for two separate input channels independently controlled and in which tone compensation is embodied costs £10 10s. This equipment is AC operated.

Shaftesbury Microphones have evolved a 15-watt portable amplifier which can be operated from AC, DC, or batteries, the change from mains- to battery-operation being effected by plug and socket connectors, as a rotary converter is built into the cabinet. A gramophone turntable is included, and the price complete is £36 10s.

The latest addition to the Sound Sales range of PA apparatus is a new 14-watt model designed to operate direct from a microphone without pre-amplification. Push-pull output is employed, and a special bias-compensating arrangement is included that enables the operating conditions of the two valves to be matched by adjusting the anode current to the same value for each valve. Known as the PA14, it costs £35. Sound Sales also make a 4- to 6-watt model, as well as several with larger power outputs. Radio units for use with their amplifiers are also available.

Tannoy G.M.45 portable equipment.

The Tannoy G.U.B.10 is a self contained AC, DC, and battery model in portable form and including a gramophone turntable. For battery operation a separate rotary converter is employed. It gives 10 to 15 watts output, and provision is made for two independent inputs, viz., gramophone and microphone. The price is 28 guineas with a spring gramophone motor, or 30 guineas with an electric model.

For battery operation in addition to mains the price is increased to 34 guineas. In all, Tannoy make no fewer than sixteen different models ranging from 6 to 50 watts output, also small PA equipment for operation solely from car batteries.

Amplifiers that can be operated from mains or batteries are gaining in popularity,

Model T262 portable amplifier made by Trix.

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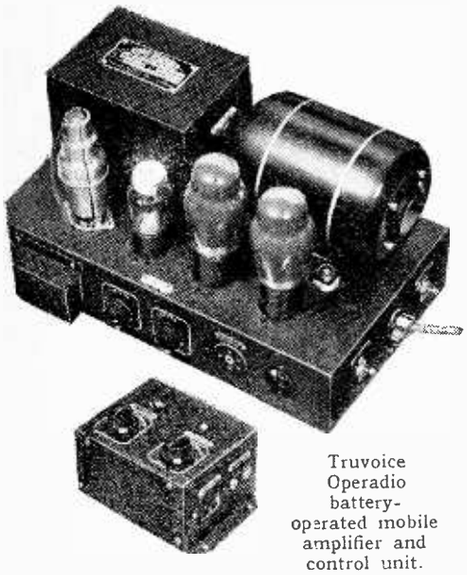
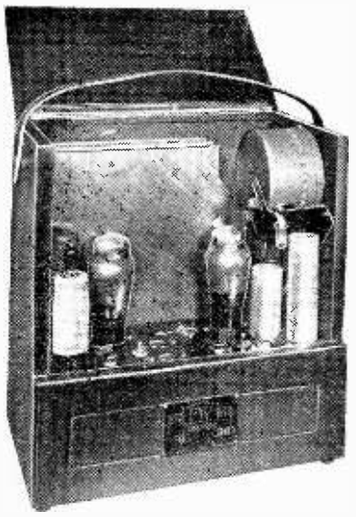
especially in the smaller sizes suitable for outdoor meetings, such as garden fêtes, sporting events, etc., and Trix now include one in their range. Known as the Type U812, it is a 10-watt model, for which a two-stage amplifying circuit is used, the output being push-pull. In a portable case and including loud speaker, microphone, rotary converter, and all necessary accessories, the price is 34 guineas. This is but one of the numerous Trix models, some of which embody gramophone equipment, such as the TP140, TP242, and TP262, which come within the category of portable PA equipment.



Truvoice Operadio battery-operated mobile amplifier and control unit.

The chassis of these sets are available as separate units, the T140, for example, being a two-stage model giving 10 watts output.

Operadio PA equipment supplied by Truvoice, Ltd., is obtainable in five different sizes, each outfit being arranged for a certain class of service. Where only a limited number of people have to be addressed, such as in a small hall or for dance band use, the No. 1 combination is supplied. It makes use of a model 818 12-watt amplifier, a moving-coil microphone, loud speakers, etc., and, complete in every detail, costs £34 14s. 6d. Where greater power is required the output from the 818 amplifier can be used to drive a "Booster" amplifier fitted with four American 2A3 valves in parallel push-pull, making available some 24 watts for the loud speakers. The additional amplifier is self-contained and has its own power supply.



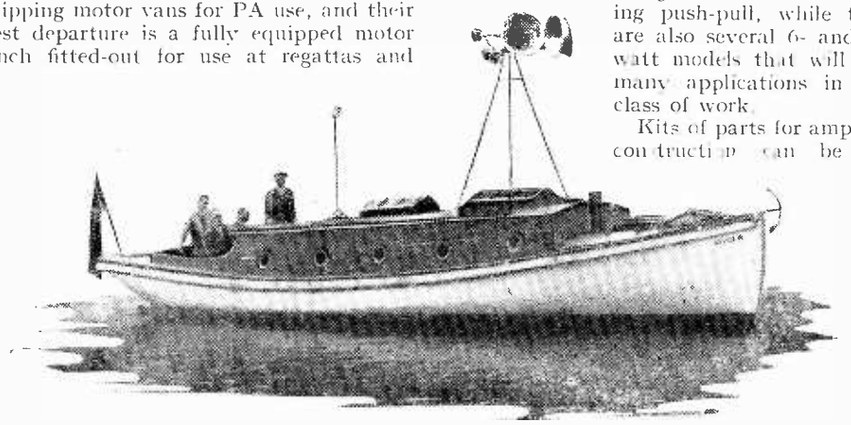
Universal portable amplifier made by Frederick Waterhouse.

An interesting model in this series is the Model 843, designed for mobile use and operating from a 6-volt accumulator. It gives 18 watts output and consumes 14 amperes of DC. A rotary converter is embodied in the chassis. The price is £25 10s., excluding valves.

Frederick Waterhouse make a number of models covering most requirements of present-day PA. They range in size from 8 to 50 watts output, and are available as amplifier chassis or assembled in portable cabinets with single and twin gramophone turntables. Larger equipment is also made, but this usually takes the form of rack-built sets for permanent installation.

A small, compact 8-watt amplifier for AC/DC operation is obtainable from Chas. F. Ward. It is a three-stage model with pentodes in the output stage, and requires 0.01 volt input to obtain the full output. Its price is £6 17s. 6d.

There are several firms that make a speciality of certain branches of PA work. Ross and Robinson, for example, are noted for equipping motor vans for PA use, and their latest departure is a fully equipped motor launch fitted-out for use at regattas and other river or coast water fêtes. Two 30-watt amplifiers are installed, and these are operated by rotary converters driven by a 50-volt bank of accumulators charged by a dynamo worked off the boat's engine.



Motor launch equipped with PA apparatus by Ross and Robinson.

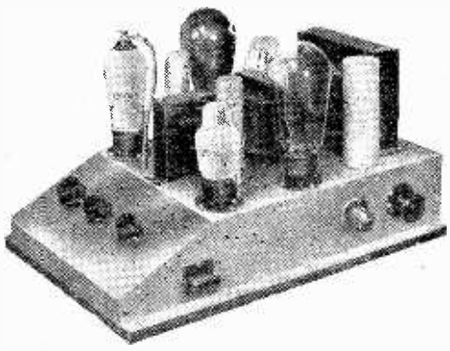
Easco Broadcast Service specialise also in PA van equipment, or, rather, fully equipped vans for mobile PA use. All such apparatus is, of course, operated by a bank of accumulators which are usually charged overnight from the supply mains by means of a battery charger installed in the van.

In all mobile PA work reliance has to be put on battery-driven converters for the required operating voltages, and it is in the production of these that the Electro Dynamic Construction Co. specialise. Low voltage to high voltage DC machines, as well as DC to AC converters, are available in all sizes necessary for PA work. Generating sets driven by a small petrol engine for field use are also made by this firm.

Crypton Equipment, Ltd., also specialise in the production of machines for this purpose.

If users of PA equipment wish to build their own amplifiers, kits of parts and designs are available, and there are several firms in a position to supply their needs.

N. Partridge has designed a range of amplifiers, and supplies constructional details and advice to those who may require them. The available designs cover a 12-watt model, a 30-watt model, and several single- and two-stage microphone pre-amplifiers. Microphone technique and similar subjects are dealt with very fully in the Partridge PA Manual.



One of the constructor-type amplifiers designed by N. Partridge.

Ferranti supplies constructional details of a range of amplifiers some of which are well suited for PA work. The Type AC32C, for example, is a 32-watt model using two PX25A valves in low-loading push-pull, while there are also several 6- and 12-watt models that will find many applications in this class of work.

Kits of parts for amplifier construction can be obtained from Universal High Voltage Radio, Ltd.; these models are all for AC, DC operation and cost from 6 guineas to 10 guineas, according to the size of the unit required. From the Peto-Scott Co. and also from British Television Supplies either parts or complete models of the various *Wireless World* amplifiers that have been described from time to time can be obtained. These include a 12-watt model for AC mains, a universal mains model, and various associated units.

Some of the firms mentioned as makers of PA equipment also supply parts for the construction of the apparatus. Ferranti, Partridge, Sound Sales and Savage are makers of mains transformers and chokes, while All-Power Transformers, Haynes Radio, Bryce, Paramount Mains Transformers, Rich and Bundy, Vortexion, Varley and Wearite, among others, also specialise in this class of component.

"Wireless World" Microphone

READERS who may be contemplating making the *Wireless World* transverse current carbon microphone may be interested to learn that a revised reprint of the article which appeared in an issue now out of print is obtainable from our Publishing Department at the price of 2d., post free.

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Acoustics of Theatres

EXPLORING SOUND DISTRIBUTION BY MEANS OF AN OPTICAL MODEL

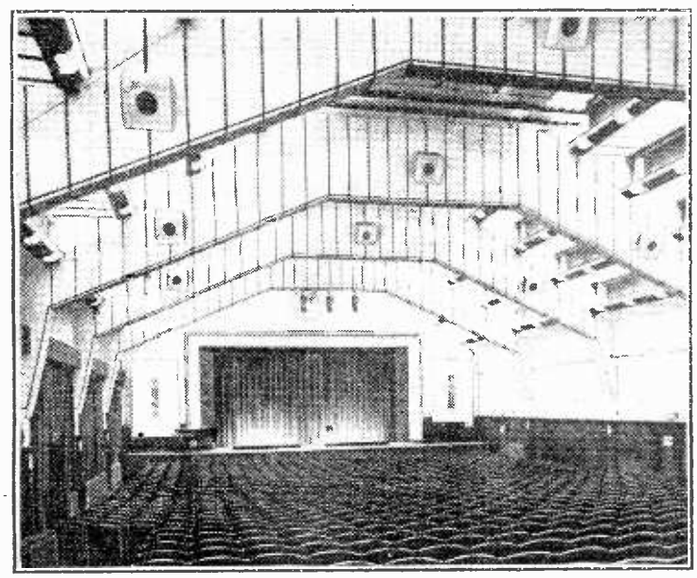


Fig. 1 (a) (Left).—Auditorium of the Philips Theatrebefore reconstruction.

THE task of the acoustic engineer would be greatly simplified if some means could be found of making pressure variations in the air visible to the eye. At the moment there is little prospect of this dream being realised, but in the meantime indirect methods of attacking the problems of sound distribution are being developed. The optical technique used in the Philips Laboratories and described in this article is of more than usual interest.

THE general principles of the science of architectural acoustics, consolidated by the classical work of Sabine and extended by modern electrical methods of measurement, are now widely known. It is unlikely that we shall see any repetition of the grosser errors of proportion which resulted in the notoriously bad acoustics of some of the famous public buildings of the last century; but the detailed elucidation of the acoustics of a hall of complex form in terms of general principles is such a formidable problem that it is customary to obtain experimental evidence from scale models.

The usual method is to prepare a series of sections and to study the reflection of waves at various points in the ripple tank or by means of spark photography. The correlation of the results requires, however, a good deal of experience and the final recommendations contain, from a scientific point of view, rather a high proportion of personal judgment.

The experimental technique developed in the Philips Research Laboratories[1] must, therefore, be regarded as a notable advance in the art. Instead of the two-dimensional sections used in the ripple tank, a three-dimensional model of the roof and walls of the hall is constructed in sheet aluminium. The source of sound is replaced by a small lamp, and the floor of the model consists of a sheet of opal glass. Multiple reflections result in the formation of a light pattern on the glass which gives a picture of the distribution of sound intensity.

Suitable precautions are, of course, necessary to ensure the validity of the analogy between light and sound distribution. The surface of the opal glass is treated to give a low reflecting power corresponding to a coefficient of absorption for the audience of 0.9 to 0.95. About 50 per cent. of the light is absorbed at each reflection from the aluminium, so that after three reflections about 10 per cent. of the original intensity remains. This contributes very little to the total illumination of the plate, so that the pattern is made up mainly of direct light and first and second reflections corresponding to "useful" sound—i.e., sound reaching the ear within $\frac{1}{15}$ second after the arrival of the direct sound.

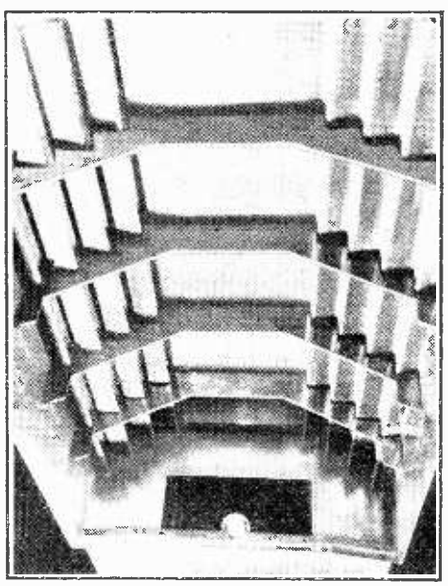
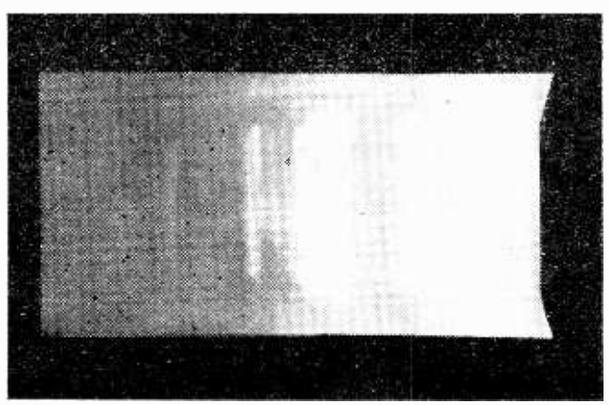


Fig. 1 (b).—Optical model of the original Philips Theatre. You are looking upwards through the "floor" with the opal glass representing the audience removed. Note the lamp which takes the place of the source of sound on the stage.

Fig. 1 (c) (Right).—Photograph of the opal glass in the model of the old Philips Theatre.



At low frequencies, where the wavelength of sound is comparable with the dimension of many of the reflecting surfaces to be found in the average hall, diffraction takes place and the analogy breaks down, but for the high frequencies (1,000 cycles and above), which determine articulation, the light pattern gives a true picture of the sound distribution.

The method is, therefore, specially suited for investigations into the design of theatres, and was, in fact, employed during the reconstruction of the Philips Theatre to the plans of Prof. Witzmann, of Vienna. The poor sound distribution of the original hall, Fig. 1 (*a*) as revealed by the optical model, was due to the roof trusses, which were enclosed by glass panelling and resulted in irregular reflection from the ceiling. In reconstructing the hall the roof was to be raised and a new ceiling built under the trusses, the sides of the

[1] R. Vermeulen and J. de Boer, *Philips Technical Review*, Vol. 1, No. 2.

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Acoustics of Theatres—

stage modified, and a balcony added at the back. An optical model showed greatly improved distribution, with direct sound predominating in the fore part of the auditorium and reflection from the ceiling providing most of the intensity at the back. As a result a strong shadow was thrown over the audience under the balcony.

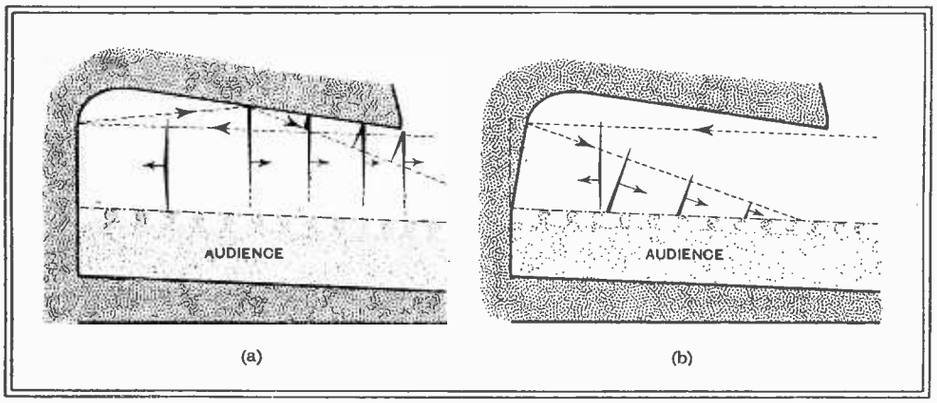

Fig. 2.—Diagrammatic sketch showing path of sound wave under the balcony of the redesigned Philips Theatre, (a) with vertical rear wall showing concentration of wave above the heads of the audience, (b) with rear wall sloping forward to direct sound downwards.

The area under the balcony was then examined by the ripple-tank method, which is specially suitable for single details of this nature. It was found that the rear wall reflected a strong wave, but that the contour of the underside of the balcony caused a concentration of the reflected wave which passed over the heads of the audience. This was remedied by sloping the rear wall forward, care being taken that the downward reflection was limited to the area under the balcony. Striking confirmation of the success of this expedient was provided by the now practically perfect illumination of the opal glass in the correspondingly modified optical model, Fig. 3 (*b*). The redesigned hall has proved entirely successful and the words spoken on the stage are clearly intelligible at all points in the hall, including the area under the balcony.

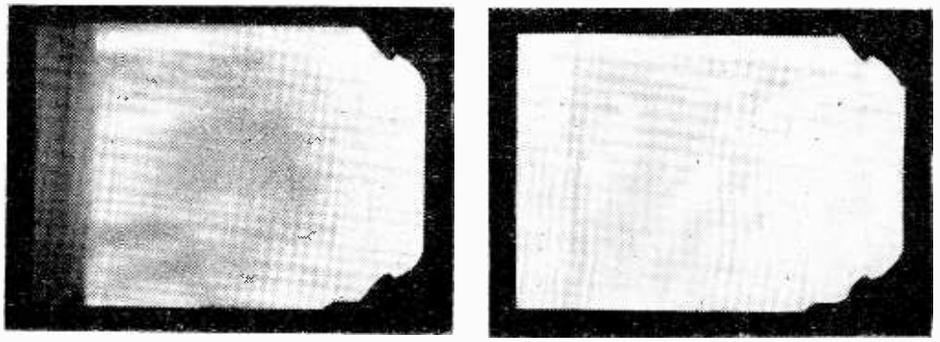

Fig. 3.- Photograph of opal glass in models of new theatre with vertical and sloping rear walls corresponding to (a) and (b) of Fig. 2.

On The Short Waves

IN the past it has been an accepted fact that if you wished to increase the direct-ray Class A service area of a medium-wave transmitter it was possible to (a) use a mast of greater height, if the optimum height mast(s) were not already in use, (b) increase the power, or (c) secure, if possible, a lower operating frequency; always bearing in mind that, in any case, the limit of the non-fading radius would be about 80 miles as far as the medium waves are concerned.

During the last few years, therefore, we have seen erected mast radiators of upwards of 700ft. in height, for example, in New Zealand, U.S.A. and Hungary; transmitters using powers up to 500 kW, such as Moscow on the low frequencies and WLW Cincinnati on the medium-high frequencies, and, finally, the general use in Europe of the so-called long-wave, or low-frequency, band.

It seems to have been forgotten, however, that in the early days of broadcasting receiver (and transmitter) design problems had a considerable effect on the choice of operating frequency, and in this connection no doubt many readers can recall the very low wavelength of 261 metres used by Brussels, which was unobtainable on most receivers even with the "tuning condenser in the series position"!

It seems, therefore, that the original technical considerations governing the choice of the present major broadcasting band were that the frequencies involved were the highest for which receivers and transmitters could conveniently be made, and that it was relatively clear of established stations and services.

To-day, however, the picture is considerably changed, since this band is probably now the most "congested" one in the ether, although by rigid working to rules laid down by the various "Plans" it still remains of considerable value, and, secondly, efficient receivers can now be made cheaply for much higher frequencies than those envisaged for broadcasting in 1922.

The new theory is, therefore, that we might improve our service area, all other things remaining equal, if we considerably *increased* our operating frequency instead of *decreasing* it, and the consideration of this theory has received considerable impetus since the establishment of the Alexandra Palace television transmitters.

These transmitters have a Class A non-fading service area, which, considering the low power used, 3 and 17 kW, bears comparison with the London National service area even before this transmitter was placed into isochronous service with the other national transmitters, and appears in Brighton to be more satisfactory than even London Regional after nightfall, at least in signal-noise ratio, apart from ignition interference. The only point near London where reception appears to be relatively poor is in that part of Surrey (Reigate, etc.) lying under the escarpment of the North Downs.

The point which seems to have been overlooked is that for a direct-ray service (the only really satisfactory basis for a high-quality national service) the use of the ultra-high frequencies permits the erection of extremely efficient aerials—the gain of which (for a given mast height) may more than offset the increased propagation or earth loss, especially when simple elevated aerials are used at the receiver, which latter already seems to be the practice in any case.

A fascinating comparison can be made between the London Regional aerial at Brookmans Park, 180ft. high approx. on 342 metres, and a similar aerial for use on 5 metres, in the latter case a piece of wire 2ft. 6in. high, with a top hamper of similar dimensions stuck in the garden, would be about true to scale. One would, of course, not expect to transmit far with such an aerial, especially when by comparison an extremely elegant array could be accommodated on 50ft. poles.

It is difficult at the moment to say exactly what will happen, but it certainly seems that the future is full of possibilities on the ultra-high frequencies, although it must be borne in mind that no sudden change-over is likely owing to the vast number of medium- and long-wave receivers in use which tune to the established frequencies only, so that any developments will be gradual in character.

Here we leave the realms of possibilities and enter the cold facts of short-wave reception during the past fortnight.

Conditions during the early part of the period considered were of the typical low sunspot activity winter type, showing considerable improvement during the last week of January, with the advent of yearly "February" sunspot peak on January 26th.

On Wednesday, January 13th, evening conditions were fair, W2XAD only of the U.S. stations being worth while, the same state of affairs holding on Thursday and Friday, although a minor increase in solar activity during this period resulted in improved signals from W3XAL on 17.78 Mc/s in the evenings.

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At 11 p.m. on Saturday, January 16th, W2XAF was fair, but fully intelligible, and the optimum band for long-distance reception appeared to be from 10—5 Mc/s at this time.

The 28 Mc/s U.S. amateurs provided some good signals during Sunday afternoon, January 17th, and later W2XAD maintained his signal strength and good programme value until nearly close-down at 9 p.m.

After 9 p.m. reception on the 9 Mc/s band was quite good, W1XK being best followed by W2XAF and W3XAU.

Even W1XAL was "good" on 6.04 Mc/s when the Russian "picture" transmitter RDD permitted.

With a fall in activity conditions became poorer on Monday, W2XAD and W1XK were satisfactory, with W2XAF fairly good at 11.50 p.m. On Tuesday conditions again improved, with W3XAL excellent on 17.78 Mc/s at 9.30 p.m., W2XE very good on 15.27 Mc/s, and W1XAL good on 11.79 Mc/s.

A note for Wednesday was the excellent relay by Tatsfield of President Roosevelt's inaugural speech, taken from W2XAD, I believe.

Conditions improved again on Friday, January 22nd, and here, after noting W2XE as good on 21.52 Mc/s at 6.35 p.m., we can give his new schedule:—

Mc/s.	G.M.T.	
21.52	1230-1700	European beam.
17.76	1700-1800	
15.27	1800-2300	
21.52	2300-2400	S. American beam.
11.82	2400-0300	
6.12	0300-0400	

After January 23rd conditions steadily improved, with perhaps a poorish day on Wednesday, January 27th, the daylight frequencies on some occasions remaining in until nearly midnight, in particular the 14 Mc/s amateur band was excellent at 12.40 a.m. on January 23rd, on which date W1HQN and W8JFC were outstanding R9 signals on 28 Mc/s in the afternoon.

ETHACOMBER.

"To What Base Uses"

REFLECTIONS ON THE DARKER SIDE OF PA

By C. ERIC DUST

THIS PA business has reached amazing proportions in a comparatively short space of time. From being a medium of entertainment it has become an essential to many commercial undertakings, and has been adopted by the Navy, Army and Air Force, and by steamship lines and railways. Each day some new and surprising use is found for this offspring of radio.

PA equipment is doing noble work in many spheres. It has, as it were, been co-opted to the advantage of all concerned. But to what base uses is it being put in less peaceful climes than ours! In many of the authoritarian (or should it be totalitarian?) countries, where the State is everything and the individual is nothing, it appears to be necessary to tell the citizens and keep on telling them very loud and clear, just how jolly everything is.

Giant aircraft, equipped with colossal amplifiers and loud speakers out-stentor Stentor, disseminating propaganda to all and sundry upon every possible and impossible occasion—upon their up-rising and their down-sitting, upon their going out and their coming in, even unto the bitter end.

We Are Not Guiltless

Ghastly, isn't it? Just imagine large chunks of language fed into a microphone and amplified umpteen thousand-fold. The resulting output must beggar description! Can it be that this is part of a campaign for the survival of the fittest?

Recent reports suggest that our own Air Force have been making use of "flying amplifers" to convey disapproval at long range to refractory tribesmen. Of course, these charming folk have hobbies just a little more sanguinary than ours, but surely they have done nothing to justify such extreme measures. Not quite "old school tie," is it?

I feel sure that *Wireless World* readers cannot have realised the petrifying possibilities of PA in the hands of pernicious or pugnacious people. Suppose someone started that sort of thing over here. What *could* we do? After all, you can't argue with a gentleman whose voice is measured in kilowatts, and, obviously, those jolly little ear protectors that the Gunners used in the last "spot of bother" would not be of much use, because the wild men who live behind doors marked "LAB" would just shovel in a few more watts, and that's watt; sorry—that's that.

If we counted upon merciful deafness to curtail our sufferings, we should again be unlucky. The bony structure of the human frame would, by a process of evolution, become so sensitive that instead of a pain in the ear, we should get a pain in the neck, and, to add to our troubles, we should have to use specially designed amplifying equipment for ordinary conversation. Very nice for manufacturers, but another pain to us—in the pocket this time.

The most likely invention so far available for the public safety hails from Hollywood. This intriguing gadget takes the form of a filter which is guaranteed to make the "goldurnest Amurrican" accent sound "quate nace." This gives an opportunity to those unfortunate screen stars who every time they open their mouth put their foot in it. My idea is that this invention could be developed to mitigate the rigours of too-powerful PA.

Of course, we cannot expect disseminators of PA frightfulness to permit filters to be fitted to their mikes or amplifiers, but surely it would be possible to evolve a neat pocket device to filter at the receiving end, so to speak. An equipment such as this would filter out all obnoxious sounds and, if desired, could substitute speech or music pleasing to the user.

From the bottom of my public-spirited heart I present this brilliant idea, with its stupendous possibilities, to any *Wireless World* reader with a turn for research work. I even enumerate a few of the potential markets to which he can look for financial reward:—

Export to poor benighted foreigners bowed beneath the blast of PA at its pithiest.

Private soldiers, for use in filtering the sergeant-major's liver.

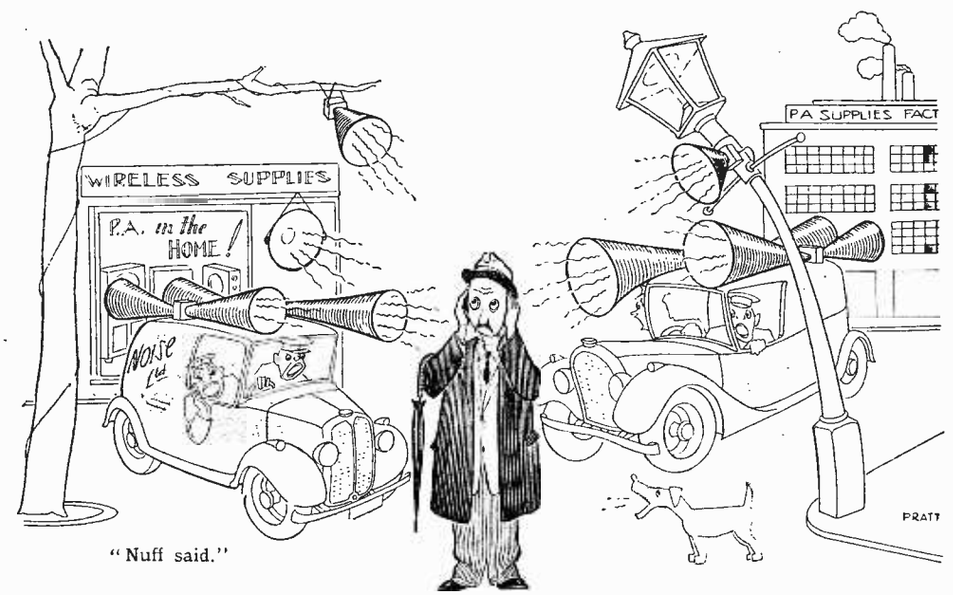
Henpecked husbands, for curtailing curtain lectures.

Jerry-built householders, for use during next-door's soup course.

Music-lovers, to transpose "kitty's love song" to a Beethoven sonata.

And so *ad infinitum*.

I trust that British PA manufacturers will forgive me for pointing out that PA has its misuses as well as its uses, and that instead of being a public benefit it *could* become a public menace. And anyway, it's up to them to supply a remedy if it does.



"Nuff said."

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Listeners' Guide

Outstanding Broadcasts at Home and Abroad

THE B.B.C. EMPIRE ORCHESTRA conducted by Eric Fogg, photographed in the Concert Hall, Broadcasting House. It will be heard by National listeners on Monday at 6.40.

MANY traditional ceremonies and customs of the country would be lost to all but a few if it were not for the medium of wireless, which so often brings them into the limelight. Two such old customs associated with Shrove Tuesday are featured in the programmes for that day.

At 12.25 National listeners will be taken over to Westminster School to hear an observer describing the scene "up school" during the Westminster Greaze. The school cook tosses a pancake over the bar that divides the Upper from the Lower school, a general scrum ensues, and the winner is the boy who emerges with the biggest portion of pancake.

In the evening at 6.40 (Reg.) will be given another West Country Calendar programme, and will feature the game of hurling the silver ball. This was at one time played all over Cornwall, but to-day only survives in its full vigour at St. Columb Major on Shrove Tuesday each year. The sides represent town and country and, there being no limit to the number on each side, from 800 to 1,000 men and boys take part. The ball used is made of apple wood covered with a stout casing of silver, and is a little larger than a cricket ball. As the game starts in the middle of the town houses and shops are barricaded, and the only law from 4 o'clock onwards is the law of the hurlers.

Recordings of commentaries with sound shots from two vantage points in the town will be given in this programme.

THEATRE EXCERPT

FOR the seventeenth programme of the series "Tunes of the Town" to-night (Friday) at 9.40 (Nat.), listeners will be switched over to the stage of the Saville Theatre, Shaftesbury Avenue, to hear an excerpt from "Over She Goes." The stars in this West End success are Adele Dixon, Stanley Lupino and Laddie Cliff. The broadcast will begin with part of the interval overture, followed by the song, "We Police," which opens the second act. During another number, "Yes, No," which will also be heard, Stanley Lupino gets the audience to whistle.

"WAIT FOR ME"

ONE of broadcasting's best-known authors and most versatile actors, Philip Wade, is the author of the new radio drama under the above title, which will be heard Regionally at 8.30 on Monday, and Nationally at 10 on Tuesday.

Details of the week's Television programmes will be found on p. 154.

As there is a strong element of surprise in the plot little of it is at present revealed, but the general theme centres round an elderly gentleman who has in his country house a room set apart to which he mysteriously retires every night for several hours. In the play many changes of scene take place, some of them being: sound shots of a hunt ball, an artist's studio in Chelsea, and a West End theatre on a "first night" performance. The production of this, the seventh of Philip Wade's radio plays, will be in the hands of Barbara Burnham.

FROM BRUSSELS

A CONCERT of light music relayed from Brussels will be heard in the Regional programme on Sunday at 6. The Light Orchestra of the Belgian Broadcasting Service will provide the programme with René Segers (accordeon) and Franz Gilman (piccolo) as the soloists. This orchestra can be divided into two sections, one for playing popular dance music and the other, composed entirely of wind instruments, for playing old dances and country tunes. This feature will be demonstrated during this Sunday evening programme.

MUSIC

AT the Sunday Orchestral Concert this week at 6.30 (Reg.), Thelma Reiss will play the Dvorák 'Cello Concerto and Adrian Boult will conduct the Introduction and Allegro by Arthur Bliss and Haydn's Clock Symphony. Thelma Reiss is considered to be one of the best of the younger generation of English 'cellists.

The Symphony Concert from the Queen's Hall on Wednesday will be conducted by Sir Henry Wood, and broadcast Nationally at 8.15 and 9.25. Arthur Rubinstein will play the John Ireland Pianoforte Concerto and the Liszt No. 2 in A. The Symphony will be the Mendelssohn No. 4 in A (the Italian), and a feature of the programme will be the performance of Rachmaninoff's "The Bells," in which the soloists will be Isobel Baillie, Parry Jones, and Harold Williams, supported by the Philharmonic Choir. "The Bells" is divided into four sections: silver sledge bells, mellow wedding bells, loud alarm bells, and funeral bells.

On Thursday the Royal Philharmonic Society's Concert, conducted by Malcolm Sargent, will be broadcast from the Queen's Hall. The programme will consist of two works: William Walton's "Belshazzar's Feast," at 8.15, and Mozart's Unfinished Mass in C Minor, which will be sung by the Huddersfield Choral Society, Isobel Baillie, Elsie Suddaby, Webster Booth, and George Hancock at 9.10.

JACK BENNY, America's leading radio humorist, will be heard with Mary Livingston, his wife, and Ken Baker and his orchestra during a fifteen-minute variety show relayed from an N.B.C. studio at Hollywood for Regional listeners at 9.45 on Monday.

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for the Week

A WREN CHURCH

AT the time of going to press, the fate of one of Wren's famous churches hangs in the balance, for it is proposed to sell the site of All Hallows', Lombard Street, and use the money for the erection of churches in new areas. This church, which still bears the marks of being damaged in the Great Fire, will be the scene of the service to be broadcast on Sunday at 7.55 (Nat.). The address on this occasion will be given by the Rev. P. S. Kangaramanujam, a converted Hindu. Will the pronunciation of this name present a tongue twister for the announcer?

PUSHKIN

ALEXANDER PUSHKIN, the Russian poet, died on February 10, 1837, and the centenary of his death will be commemorated by special programmes at home and abroad. On Tuesday, at 8.15 (Reg.), will be heard readings from his works, whilst on Thursday, at 6.30 (Reg.), Tatiana Markushina is to give a recital of Pushkin's poems set to music by Russian composers.

From the Continent comes three Pushkin programmes. On Wednesday, at 9, Brussels No. 1 gives "Boris Godunov," the libretto for which was written by Pushkin. On Thursday, at 6, Warsaw, and at 8, Moscow, give special centenary programmes of Pushkin's poems set to music.

OPERA

LISTENERS have four operas, or parts of operas, to choose from on Friday evening. "Faust," from Hilversum at 8.40; "Cavalleria Rusticana" and "I Pagliacci" from the State Opera relayed by Vienna at 6.25, and "Russlan and Ludmilla" (Glinka), of which Prague gives a concert version at 8. The latter, which is seldom heard, is founded on a poem of Pushkin, and represents the supreme effort of Glinka's genius. Its Russian composer has employed the music of the neighbouring East side by side with the characteristic melodies of his native land.

"La Traviata," from the Royal Flemish Opera in Antwerp, is the only opera event of Saturday, and will be heard from Brussels No. 2 at 8. Sunday brings an unnamed opera from the Opéra-Comique, relayed this time not by the Paris stations, but by Strasbourg and Rennes at 8.30. From Monday until Wednesday carnival, with all its familiar revelry, dominates the programmes, and there is therefore little opera. Wednesday brings an unfamiliar opera of Gabriel Pierné, "Fragonard," from Radio-Paris at 8.45.

Thursday's only opera is "Thaïs," from the Municipal Theatre, Metz. Those who love Massenet's sensuous music find it in its most characteristic style in "Thaïs."

FOURTEEN-YEAR-OLD DRUMMER; Bobby Brown, who is playing in the Grosvenor House Dance Band which is directed by Sydney Lipton. The band will broadcast Regionally at 10.25 to-night (Friday).

CARNIVAL

THE Rhineland Carnival ends on Tuesday, and the German programmes until then bristle with carnival material. On Sunday at 7 Frankfurt provides a relay from one of the famous Rhineland Carnival institutions, "Visitor's Carnival Conference," from the Town Hall, Mainz. At the same time from Berlin will be heard "The Festival of the Mask," which consists of a selection of tunes from carnival operettas. Monday, known as Rose Monday, provides a number of interesting relays. From Munich, between 10 and 11, O.B.'s from four famous balls will be heard. Earlier in the evening at 7.10 Cologne gives a Rose Day Radio Procession. On Tuesday most of the German stations from 7.10 onwards give special programmes associated with this great carnival.

UNUSUAL INSTRUMENTS

RARE compositions, for a combination of instruments very seldom heard, will be radiated from the Danish stations on Saturday at 7 by Alberto Bracony and Folmer Jensen. The programme comprises a Rondo by Diabelli and a Sonata by Ferd. Carulli, both for guitar and cembalo, and Sonatina and Adagio for mandoline and cembalo by Beethoven.

AMATEUR DANCING

TEN amateur dancing couples from England and Denmark are entered for the Anglo-Danish dancing match which takes place in the big hall of Idraetshuset, Copenhagen, on Sunday night. The Danish stations will broadcast a running commentary on the final round from 9 to 9.30. This will include a brief summary in English for the benefit of English listeners.

"PASTORALE"

THE feature of this week's Thursday concert from Copenhagen, which begins at 7.10, is Beethoven's Sixth Symphony, the famous "Pastorale," with its colourful musical impressions of the countryside.

THE AUDITOR.

HIGHLIGHTS OF THE WEEK

FRIDAY, FEBRUARY 5th.

Nat., 7.40, "Broadway." A New York Melodrama. 9.20, European Exchange, V—Germany. 9.40, Excerpt from "Over She Goes."

Reg., 6, B.B.C. Theatre Orchestra and Bétove (entertainer). 8.15, Music of Debussy. 9, Swing Music relayed from U.S.A.

Abroad.

Vienna, 6.25, From the State Opera —"Cavalleria Rusticana" and "I Pagliacci."

SATURDAY, FEBRUARY 6th.

Nat., 2.50, Wales *v.* Scotland, Rugger Commentary from Swansea. 6.45, Band of His Majesty's Irish Guards. 10.10, B.B.C. Theatre Orchestra and Alleyne and Leonhardt (two pianos).

Reg., 7.30, The Celebrity Trio. 8, The London Symphony Orchestra and Arthur Catterall.

Abroad.

Brussels No. II, 8, "La Traviata" (Verdi) from the Royal Flemish Opera, Antwerp.

SUNDAY, FEBRUARY 7th.

Nat., 5.45, "Mendelssohn in Kensington"—the Barrington Vocal Quartet. 6.30, London Palladium Orchestra. ¶The Budapest String Quartet.

Reg., 5, Hanwell Silver Band and Robert Easton. 6, Concert from Brussels. 9.5, B.B.C. Theatre Orchestra.

Abroad.

Lyons, 8.30, Modern French Music.

MONDAY, FEBRUARY 8th.

Nat., 6.40, B.B.C. Empire Orchestra. 7.20, Tenth Entertainment Parade. ¶It's Happening Now. 8.30, Van Phillips and his Two Orchestras.

MONDAY, FEBRUARY 8—*Cont.*

Reg., 6, B.B.C. Military Band and David Buchan (piano). ¶B.B.C. Orchestra (D) and Jelly D'Aranyi and Adela Fachiri (violins). 8.30, "Wait for Me."

Abroad.

Most German Stations, from 6 onwards, give special "Rose Monday" programmes.

TUESDAY, FEBRUARY 9th.

Nat. 5.15, Luigi Voselli and his Hungarian Orchestra. 8.15, "Masculine Fame on Parade"—a satire on yesterday's heroes. ¶Church, Community and State —V." 10, "Wait for Me."

Reg., 6.40, West Country Calendar, 8.35, Recital—Clive Carey (baritone). ¶B.B.C. Theatre Orchestra.

Abroad.

Rennes, 8.30, "Carnival in Music"—Gala Concert.

WEDNESDAY, FEBRUARY 10th.

Nat., 6.40, Peter Yorke and his Orchestra. ¶B.B.C. Theatre Orchestra. 8.15 and 9.25, Symphony Concert.

Reg., 6.45, From the Judging Ring at Cruft's Dog Show. 8.15, "Eight Bells."

Abroad.

Berlin, 8.15, "The Sore-Head"—An Ash Wednesday Cabaret.

THURSDAY, FEBRUARY 11th.

Nat., 6.20, This Way Out—John Hilton. 7.30, Music of Haydn Wood. 8.15, Strange to Relate.

Reg., 6.20, Reginald King and his Orchestra. 8.15 and 9.10, The Royal Philharmonic Society's Concert.

Abroad.

Warsaw, 6, Pushkin Centenary Programme.

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BROADCAST BREVITIES

NEWS FROM PORTLAND PLACE

High Fidelity Transmission

THE next move in the ultra-short wave high fidelity campaign rests with the wireless manufacturers. So far as the Broadcasting House roof-top transmitter is concerned, the B.B.C. is "all dressed up and nowhere to go."

When the "trade" indicates that it is ready to supply a public demand for ultra-short wave receivers, the B.B.C. will be able to start the necessary transmissions at a few days' notice.

Possibly there is a fear in certain quarters of the industry that high fidelity reception might lead to dissatisfaction with the transmissions on the medium waveband. If so, this is just one more proof that the spirit of King Canute still hovers over the radio trade as it did when television started last autumn.

Sooner or later discerning listeners will demand the best that radio can give, and if the ultra-short waves supply this need no amount of "hooey" and sales talk will hoodwink them. Of course, not all listeners are discerning. . . . .

Television Programmes in Sound ?

MANY of these discerning listeners, by the way, are already picking up the sound transmissions from Alexandra Palace on their home-constructed ultra-short wave sets and at times the experience can be very tantalising, particularly during dramatic sketches, where more than half the excitement derives from the action, and during the conjuring and juggling acts.

The possibility of including certain television items in the sound programmes is now being discussed, but the scheme bristles with difficulties.

Selecting the Items

Generally speaking, television programmes are not designed for reception on sound alone, consequently the task of selection would be no easy one. To "put over" television fare merely to show listeners how much they are missing would only exasperate, and this is not the intention.

That B.B.C. Staff Association

AS these lines are read, Sir John Reith will probably be studying a preliminary report submitted to him by Mr. W. St. John Pym regarding staff associations in various big undertakings throughout London. Investigations have been made with the idea of discovering how a B.B.C. staff association could be formed on similar lines.

Although Mr. Pym, who is the B.B.C.'s Director of Staff Administration, has not confined his enquiries to Government Departments, it is believed that he favours a staff association run on Government Department lines, or closely modelled on those adopted by organisations of a similar kind.

The Staff Must Choose

Of course, the final decision to form an association rests with the staff, who will be asked to express their views by means of a secret ballot.

In the meantime a sort of competition is going on among various outside Trade Union organisations anxious to make hay while the sun still shines. These organisations are canvassing the B.B.C. staff to join their particular unions.

Verbose Viewers

THE television census initiated on Boxing Day has yielded interesting results, but it was not to be expected, perhaps, that the B.B.C. would disclose the actual figures. It can be stated, however, that nearly 70 per cent. of private owners of television sets responded to the appeal, most of them filling up their forms with such enthusiasm, even verbosity, that the census officials have had quite a job in sorting out the facts from a wealth of comment.

Clearly, purchasers of 95-guinea television sets are anxious that the service shall be a success.

Melodramo Most Tearful

ONE of the most arresting melodramas of Victorian days, when all that theatre audiences craved for was the ultimate triumph of the hero and the undoing of the villain, is to be broadcast on March 16 (National) and 18 (Regional). It is called "Ticket of Leave Man," and Peter Creswell is now spending days and nights in delving into the history of the Olympic and other theatres of the Victorian era, to "sense" the atmosphere associated with plays of this calibre, in order that "Ticket of Leave Man" may be produced in all its original poignancy.

Suffering Hero

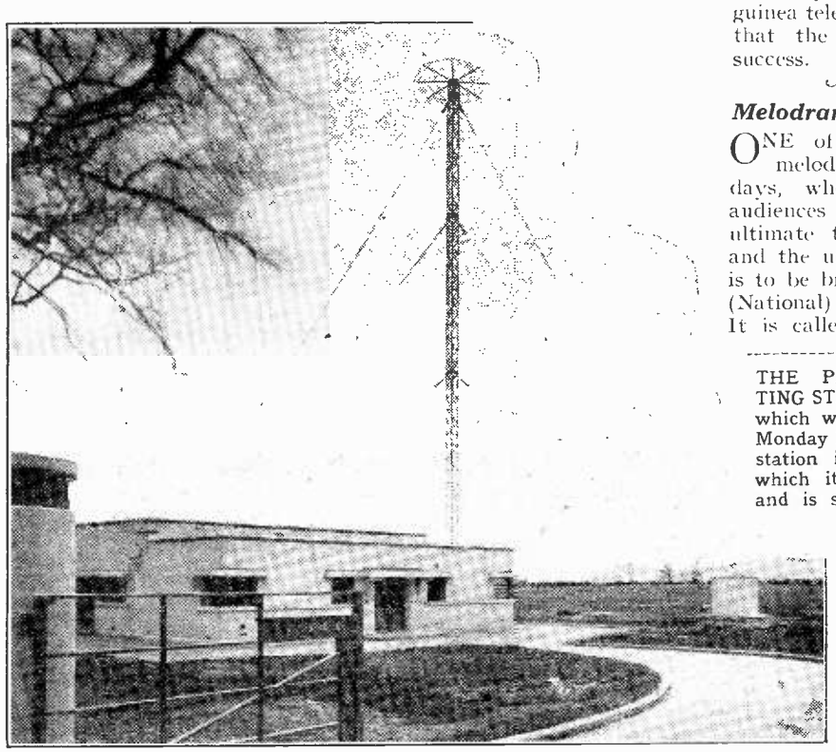
The play was first produced in 1863 with Kate Saville and Horace Wigan, famous artists of their time, in leading roles. It is said to have caused even the hardest boiled audiences to dissolve into floods of tears; certainly it secured for its author, Tom Taylor, a definite place in theatrical history. The hero manages to get himself wrongfully accused of a variety of misdemeanours with uncanny regularity, but is buoyed up by the loyalty of the heroine, who sticks to him through thick and thin.

Ballads of the period will add colour to the show, and Mr. Creswell will endeavour to convey the sense of listening to an actual theatrical performance by using only one studio for the broadcast, complete with cast, orchestra, singers and audience.

"B.B.C."

WHEN all the best humour is supposed to originate in America, it is refreshing to hear of a Los Angeles organist who wrote to the B.B.C. the other day to compliment it on the good fun in the Christmas broadcast to America. The Corporation's initials, he suggested, should stand for Britons Being Comic.

"Two or three of my friends," he added, "said that they had no idea that English people could be so funny. I wish to goodness we could have more of these broadcasts here."



THE PENMON TRANSMITTING STATION near Beaumaris which was officially opened on Monday last. A feature of the station is the 250 foot mast which itself acts as the aerial and is surmounted by a capacity ring 40 feet in diameter. The power of the transmitter is 5 kW. The transmissions are on the same wavelength (373.1 metres 804 kc/s) as the West Regional at Washford to which station the frequency is synchronised.

KNIGHTED. Adrian Cedric Boult, D.Mus., LL.D., Mus. Doc., F.R.C.M., who has been Director of Music of the B.B.C. since he joined the Corporation in April, 1930, was created a Knight Bachelor in the recent Honours list.

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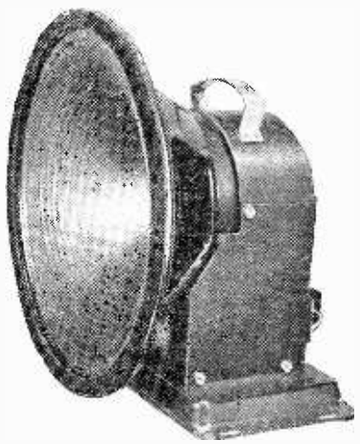
Loud Speakers for Large Outputs

A REVIEW OF THE TYPES MOST SUITABLE FOR PA WORK

THE diversity of PA applications is well illustrated by the variety of loud speaker types which have been specially designed for or can be readily adapted to this work. At one end of the scale we have the powerful horn-loaded projectors for outdoor gatherings, and at the other the larger of the cone type moving coil speakers which cover the transition from domestic to PA power-handling capacities.

Among units of the latter class the Rola G12 is a good example. There is a full 9in. cone with a wide frequency response and curved construction which will stand up to PA inputs without introducing spurious tones. The speaker is available for DC excitation with no fewer than seven alternative field resistances. A flux density of 12,000 lines is provided for a field consumption of 12 watts. There is also a PM model with a nickel-aluminium-cobalt magnet giving a



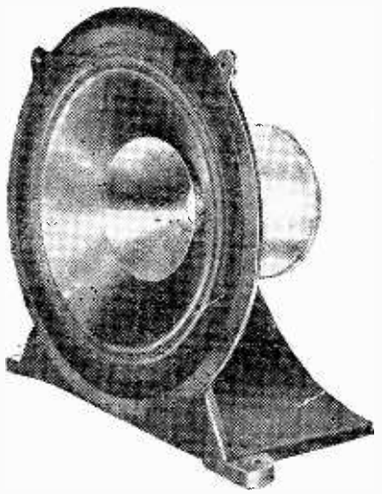
Rola G12 high-fidelity unit with full mounting. Stripped models are also available.

flux density of 11,500 lines. Stripped models are available for PA work, and a 15-ohm coil can be supplied in place of the normal 8-ohm coil if desired.

Another unit which is admirably adapted to local sound reinforcements in theatres, etc., is the Ediswan B.T.H. RK. In the latest design a curved-sided cone is employed. There is a PM model with a cobalt-nickel-aluminium alloy magnet in addition to the standard energised types.

An extended response in the upper register is not always an advantage in PA work, but for specially designed high quality equipments a speaker such as the Goodmans 12in. "Auditorium" PM can be relied upon to give quality which is much above the average. The powerful permanent magnet provides an average flux of 16,000 lines, and the dual diaphragm with seamless exponential auxiliary cone gives a uniform response with no signs of a cut-off before 12,000 cycles.

Another interesting unit which appears

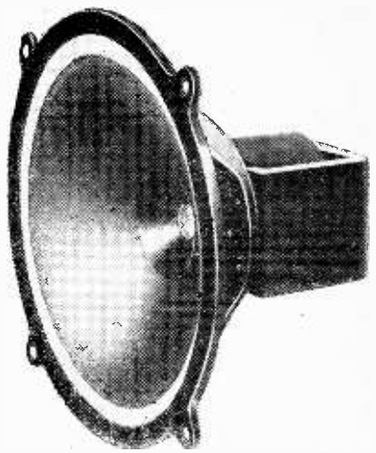


Goodmans 12-inch Auditorium PM speaker.

to be well suited for high fidelity installations is the new triple speaker designed by Bakers Selhurst Radio, Ltd. In this unit there is a main diaphragm 10 inches in diameter mounted on a surround of soft material and driven by a 2in. coil. Inside the main cone is a separate HF speaker driven by a 1in. diameter coil energised by an extension of the main magnet system. The coil is located by a domed duralumin centring device to which a truncated bakelite paper cone is attached. An interesting feature of this unit is the variable frequency response and volume control which may be effected through an extension cable if desired.

The Sound Sales Super Auditorium speaker is a good example of a unit specially designed to deal with the high inputs associated with PA work. The cone diaphragm is suspended at the periphery as well as at the apex, and an unusually wide gap of $\frac{1}{8}$in. is provided to ensure that there will be no possibility of the speech coil fouling the pole pieces. Notwithstanding this wide gap, the flux density has been maintained at the high figure of 12,000 lines by the employment of a special alloy in the energised magnet. These improvements in power handling capacity have not been made by the sacrifice of frequency response, and the output is maintained up to at least 10,000 cycles.

A range of Philips PM speakers has been specially developed for PA work. They may be used either in conjunction with a baffle or a horn. Very full technical data is available for these units, and the directional characteristics as well as the frequency response are given in each case. A feature is made of the "steel-copper" construction,



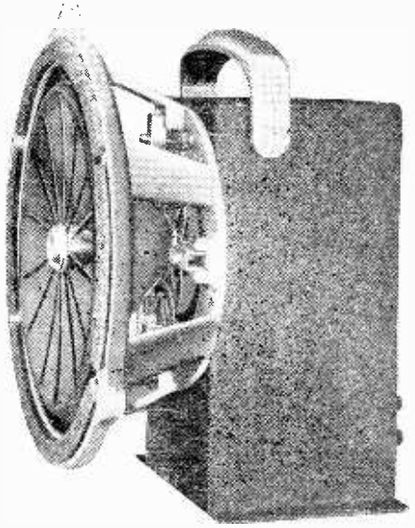
Baker "Triple" speaker with variable frequency response and volume control.

the poles being heavily plated to increase eddy current damping. The various models cover power-handling capacities from 6-20 watts and in the higher powers a special outside centring device is fitted.

The Radio Development Co., Ltd., have had long experience of the conditions and requirements covering the design of PA speakers and the Super Cinema PM model may be taken as a notable example of the type of unit which they produce. It is 22½in. in diameter and 10in. deep and will handle powers up to 30 watts. A large Alnico magnet is employed and interchangeable diaphragms are available, as in the case of the majority of auditorium speakers manufactured by this firm. Of these there is an unusually wide range, all with high power-handling capacity. The majority are designed for use in conjunction with a baffle, and a series of cabinet baffles of strong construction and neat design is available.

There is a good selection of complete loud seakers of the cabinet baffle type for indoor installations. Correx Amplifiers, for instance, market a strongly made cabinet loud speaker measuring 18in. x 18in x 11in., and capable of handling up to 20 watts with safety. These speakers are provided with standard plug-in cable connections so that the sound distribution system can be extended or modified at a moment's notice.

The Marconiphone Co., Ltd. (Special Products Department), provide a variety of baffle and cabinet speakers designed to conform with various schemes of interior



Sound Sales Super Auditorium speaker designed for sustained high volume levels.

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Loud Speakers for Large Outputs—

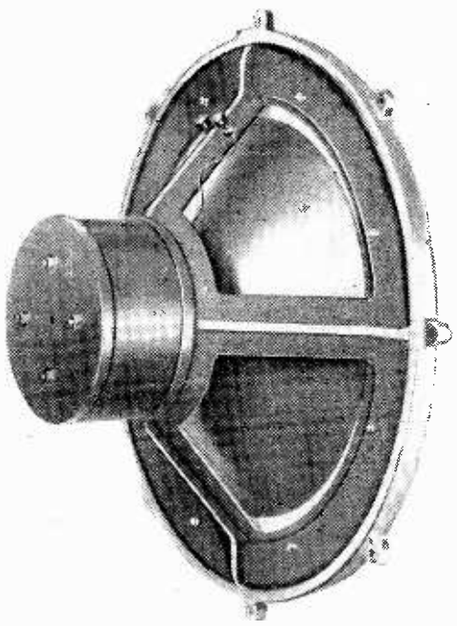
decoration in halls and theatres. A consulting architect is available to discuss special requirements.

H. Hacker and Sons have a very wide range of baffle type speakers, one of the most interesting being the Model LSB4, in which an auditorium speaker is mounted together with a horn type high-note unit in a strong box baffle 3ft. square. A field rectifier unit is included, and the speaker will handle up to 45 watts.

Magnaphone, Ltd., specialise in cabinet type speakers for stage work, and they also make a model suitable for small sideshows appropriately named the "Fairground." For high volume levels the problem of handling powers of the order of 40-50 watts has been solved in the Magnaphone "Four Fold" loud speaker by mounting medium sized units in a square reflector similar in shape to those used in floor lighting.

Parmeko, Ltd., have several high-grade moving-coil speakers, both PM and energised types, housed in a well-proportioned standard cabinet design, finished in dove-grey cellulose enamel.

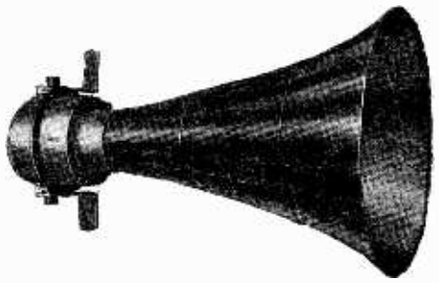
The Tannoy range of loud speakers, which



The Epoch Super Cinema PM model is 22½in. in diameter.

have in all cases been specially designed to handle the power outputs from their appropriate amplifiers, includes a cabinet model (Type J) of more than usually attractive design and good finish for theatres, dance halls, etc. They also supply an open baffle for use with the Type HF high fidelity speaker.

For outdoor work there is little doubt that the circular short horn used in conjunction with the more or less standard moving-coil cone unit is the most popular type. It is often described as a directional baffle or a semi-projection speaker, and it gives reasonably wide distribution, but is sufficiently directional to prevent acoustic feed-back to adjacent microphones. A good example of this type is the Magnavox "Two-inch" projection loud speaker, so called on account of the 2in. diameter speech coil. This is located in a gap with wide clearances by a robust rear centring device. The horn is assembled in two pieces for portability and is provided with a swivel mounting. The connecting terminals are of large size to accommodate the heavy cables usually employed in outdoor installations. The input power under continuously operating conditions is conservatively rated at 25-30 watts. A permanent magnet model with a 1in. diameter coil and a permanent magnet giving a flux of 11,000 lines is also available, the power handling capacity in this case being 10 watts.



Magnavox "Two-Inch" semi-projection type speaker.

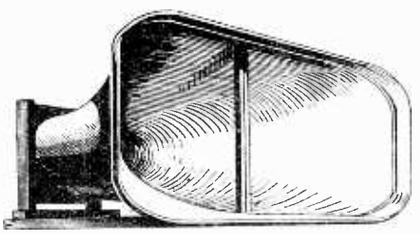
In the Marconiphone Model P540 lightweight air column projector the horn is initially exponential in form, but near the periphery it is flared to give a more gradual bass cut-off. The frequency range is 80-6,000 cycles, and with 5-7 watts input, and the effective range is 150yds. with maximum distribution through an angle of 50 degrees.

The Goodmans PA24 semi-projection speaker employs a movement with a 7in. diameter cone and a permanent magnet giving a flux density of 14,000 lines. The unit is enclosed in a felt-insulated metal container with an aperture at the back to relieve the sound pressure in the enclosed space. This aperture and the front of the diaphragm are covered by waterproof metal gauze. The horn curvature is specially designed to avoid loss at high frequencies, and power handling capacity is 10-12 watts.

Reproducers and Amplifiers, Ltd., make a speciality of a tripod supporting mast constructed of welded steel tube and provided with universal adjustments. This tripod mounts three reproducers of the semi-projection type, employing permanent magnet units with special 6in. diameter diaphragms designed to handle up to 12 watts. The standard flare diameter from projectors of this type appears to be 24in., but in the R. & A. reproducer the diameter is 26in., with a length of 20in., and there is a larger model with a 34in. diameter and length of 36in.

Wharfedale Wireless Works have developed a compact waterproof flare for use with their "Golden" and "Twin-cone Auditorium" units, of which details will be shortly available.

The type WSP waterproof semi-projection loud speaker of Correx Amplifiers is provided with an adjustable mounting bracket, and has a 7in. cone permanent magnet unit rated at 6-8 watts.



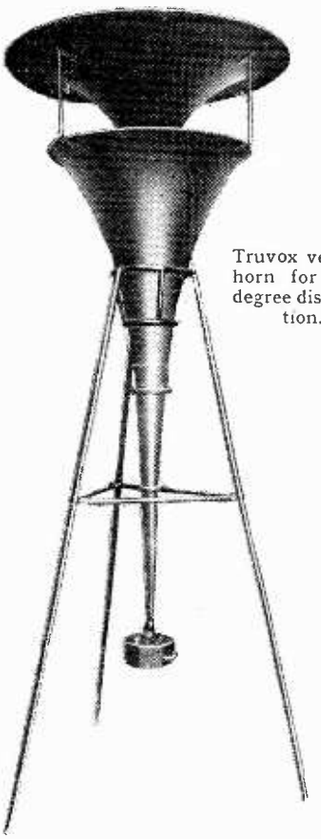
Scientific Supply Stores' "Mono-Planar" horn.

A popular modification of the circular semi-projection flare is the "Mono-Planar" horn. Scientific Supply Stores, Ltd., who were pioneers in the construction of horns both in metal and papier mâché, were one of the first, if not the first, firms to develop the "Mono-Planar" system, and the variety of types and sizes which they manufacture is too wide for detailed description in the space at our disposal. Their list includes straight and folded horns of the true exponential type with small throats, as well as the standard circular semi-projection variety.

The Epoch "Mona-Planar" horn is available in two types for the Epoch B7 and D4 permanent magnet units, and Shaftesbury Microphones, Ltd., stock a comprehensive selection of horns of this type with flares ranging from 11in.-24in.

In a rather different category, but of the same type, is the Tannoy "Giant Flat" loud speaker with a flare measuring 48in. × 18in.

Where greater carrying power and more marked directional characteristics are required the long straight horn with a small throat area is generally employed. A special moving-coil drive unit incorporating an air chamber between the diaphragm and the throat is necessary, and in general the electro-acoustic efficiency is distinctly higher than that of other types.



Truvox vertical horn for 360-degree distribution.

Truvox make a speciality of this type of loud speaker and their list of upwards of 40 models includes an interesting vertical horn having a total height of 9ft. with deflector designed to give 360 deg. radiation in an approximately horizontal plane. It is fed by a Type 6A moving-coil unit, and branch adaptors are available for using two or four units simultaneously. These units incorporate 12lb. cobalt steel claw magnets, and will handle up to 10 watts each. For indoor use there are straight exponential horns constructed of impregnated cloth material fitted into cast aluminium throats. The Type 19 horn has a flare diameter of 22in. and a length of 42in., and in the Type 20 the flare is 31in. and the length 72in. The manufacture of semi-projection type flares is also included in the activities of this firm, and

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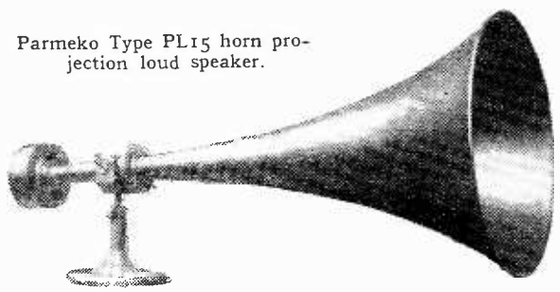
general metal work, such as the construction of amplifier racks, is undertaken to requirements of the PA section of the industry.

In the Reslo Type SU1 horn unit a non-metallic diaphragm driven by an aluminium wire coil is energised by an Alnico magnet giving a flux of 12,000 lines. A suitable horn 24in. in diameter and 42in. long is available.

The types TU1 and TU5 units made by Truvoice, Ltd., are interesting for the fact that the diaphragms are constructed of specially treated Balsa wood. In the Vitavox unit made by the same firm a



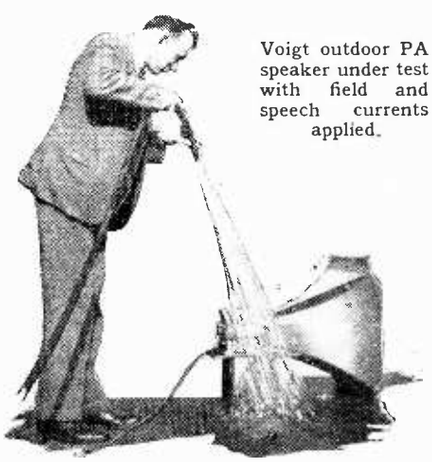
Parmeko Type PL15 horn projection loud speaker.

duralumin diaphragm is employed. Suitable horns of the straight, circular and folded "Mono-Planar" type are available. Special attention has been paid to easy replacement of the diaphragm in the movement of the Parmeko horn type loud speaker. The removal of four screws gives immediate access to the diaphragm, which is self-centring and arranged so that contacts with the coil are automatically picked up when replacing the top cover. The unit will accept inputs up to 15 watts and the 24in. horn, which is constructed of heavy gauge sheet aluminium fitted with resonance suppressors, gives a 45 deg. distribution.

The G.E.C. exponential horn assembly has a 1in. diameter spun aluminium diaphragm, and is designed to give a high conversion efficiency for fitting several units on to a single horn.

A metal diaphragm is also used in the B.T.H. 6ft. horn, which is designed for outdoor service and has a rating of 10-15 watts.

Film Industries, Ltd., were one of the first firms to develop the straight exponential horn for PA work, and their current speakers make use of improved versions of the original LS5 and LS6 moving-coil units. While the majority of the horns are of the straight exponential type there is also a folded horn



Voigt outdoor PA speaker under test with field and speech currents applied.

in box form, for portability. Another useful and compact folded horn is the "Jekta" diffuser made by Grampian Reproducers, Ltd.

Finally, there is the Voigt loud speaker, which, technically, occupies a position intermediate between moving-coil units with directional baffles and exponential horns with a small throat area. All the models in the Voigt range employ the twin-diaphragm moving-coil unit, having a field of the order of 17,000 lines and specially developed for use in conjunction with an air column load. The straight Tractrix horn with a 4ft. mouth is admirably adapted to indoor installations where a high standard of quality is demanded, and for outdoor use a weatherproof model incorporating a 2ft. square horn, which can be divided diagonally for easy transport, has been developed.

The accompanying photograph gives some idea of the standards of waterproofing to which this design has been built. It incorporates one or two interesting deviations from conventional practice. For instance, the centring spider, instead of being the usual stamping from sheet material, is an ingenious arrangement of levers designed to give free parallel movement and to stand up to sustained wide amplitudes. Also, the difficulties associated with total enclosure of the back of the unit have been met by constructing the whole of the diaphragm system of material impervious to moisture and then leaving it open.

Western Electric Mirrophonic System

A Convincing Demonstration

THE quality of the sound accompaniment to films is advanced a stage nearer perfection by the Western Electric "Mirrophonic" equipment, a demonstration of which was recently given at the Phœnix Theatre, London, W.C.2.

To some extent the development is concerned with the amplifiers, which have a greatly increased ouput and a low harmonic content at high levels, but the principal point of superiority over existing apparatus is to be found in the loud speaker system. This is a commercial development of the design originated by Dr. Harvey Fletcher, of Bell Telephone Laboratories, in which the high-frequency unit works into a cellular horn giving a wide angle of distribution. The low frequency unit employs four moving-coil cone speakers mounted in a cavity fitted with deflectors and surrounded by a rigid baffle. The change-over from one unit to the other is effected by filters with an attenuation of 12 db per octave above and below the cross over.

The wide frequency range gives remarkably faithful speech and realistic effects involving high frequencies (the swish of the rapiers through the air in the duel scene from "Romeo and Juliet"); but in our opinion the most convincing part of the demonstration was the authentic concussive effect of gunfire in a naval film, which was without the slightest trace of overload in amplifier or speakers. All the examples were chosen from standard films already released, and with the new reproduction one was able to appreciate for the first time the strides which have been made in recording in recent film productions.

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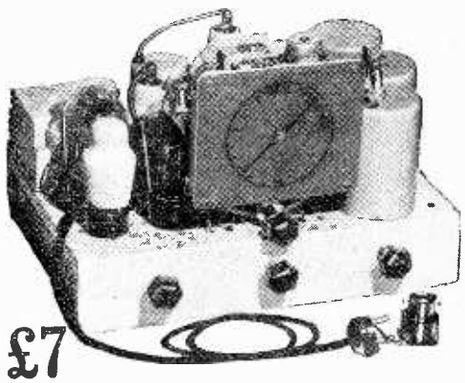

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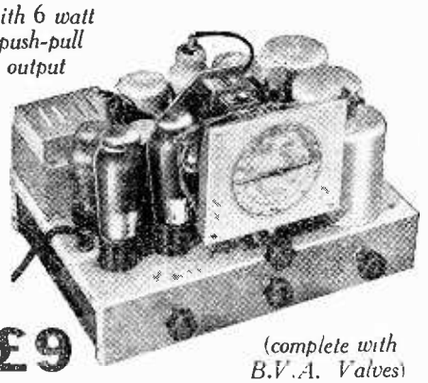

£9 *(complete with B.V.A. Valves)*

6 valve all-wave superheterodyne with similar specification, performance, etc., to above, but with large push-pull output giving 5½-6 watts.

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The Voice of the Law

CONTROLLING CROWDS AND ADMONISHING MOTORISTS

By ALAN HUNTER

SOUND amplifying equipment proved its worth in the hands of the police during the 1935 Jubilee celebrations, when it was used to control vast crowds, and, equally important, to keep them informed of passing events. It is anticipated that PA will play an even more important rôle at gatherings throughout the country during the Coronation.

WHATEVER splendours may surround the forthcoming Coronation, no one is likely to forget the spontaneous acclamation of the late King George the Fifth during the Jubilee celebrations, when enormous crowds were apt to forgather all over the West End of London in a quite unprecedented way.

It was due to the innate good humour of the English crowd and the gentle but firm methods of the police that these vast concourses were kept at once informed of events and immune from the dangers of being trampled upon.

The Jubilee saw the first really thorough trial of the PA-equipped police vans, of which there were over a dozen in use. It was an occasion on which the public learned to take heed of the stentorian voice of authority *via* the loud speaker. Equally, it was a most propitious excuse for many members of the Force to show their talents as announcers.

They exhibited, I remember, a waggish turn of phrase when controlling the apparently tireless crowds. I was given the chance to study the effectiveness of the PA vans at first hand, being at that time unofficially "attached" to the B.B.C.'s recording van.

Obedient Crowds

Two of the danger spots, alike for the public and traffic, were at Piccadilly and the Haymarket. Here I saw and heard the vans in action. What impressed me most was the ready response of the crowds to the commands of policemen they could not see. The motor cars, possibly because the drivers' senses were already fully occupied, were not quite so responsive.

Since the Jubilee the police have evidently extended the uses of PA for all forms of crowd control. Even now we are only at the beginnings of a new technique. Undoubtedly, the Coronation will be the scene of more intensive application of the new method of maintaining order.

The vans I have inspected make use of a standard Tannoy amplifier set, capable of delivering some 8 to 10 watts undistorted output to the loud speaker on the roof. This may seem on the low side for the job in hand. Experience has shown it is adequate, though.

Readers of *The Wireless World* will, in any case, appreciate that the brute force of watts output is not the only factor. In these particular amplifiers special attention has been paid to the elimination not only of frequency but of amplitude distortion.

Furthermore, the small Tannoy loud speaker is a good moving-coil cone type with a fairly short horn that lends itself particularly well to the dissemination of speech.

The microphone normally used by the police is a high-grade transverse carbon type of 600 ohms, incorporating resistance-capacity filters to remove the "hump" between 2,000 and 4,000 cycles.

Primarily designed as a universal mains outfit, this Class "B" type amplifier can also be worked from a 12-volt accumulator driving a high-tension generator—and it is, of course, used in this way by the police.

The whole equipment is extremely portable, being easily managed by one policeman. It can be attached to any vehicle with the minimum of trouble. The makers claim that its watts output per pound weight is unusually high.

Although the authorities at Scotland Yard—or the official I spoke to, anyway—seem to regard the use of these vans as in the nature of a deathless secret, it is frequently possible to witness how they are working in practice.

I managed to get on the track of one particular function of the PA-equipped police van—or, in this case I should say police car—near the pedestrian crossing at Streatham Hill station.

There the police were evidently educating the public in the correct observance of all Mr. Hore-Belisha's invaluable aids to safety. I should add that there is such a plethora of gadgets at this spot that the average pedestrian might well be puzzled.

The loud-speaking policeman did his best to elucidate the mysteries of beacons, press buttons, guard rails, traffic lights and so on. Here, again, I noticed with interest that it was the pedestrian part of the public that paid most attention, not the motorist. I take it that this is in the nature of things.

The Ministry of Transport, far less secretive than the police over these things, evidently hopes to extend the activities of the PA-equipped policemen. The new brigade of

"Move along, please."

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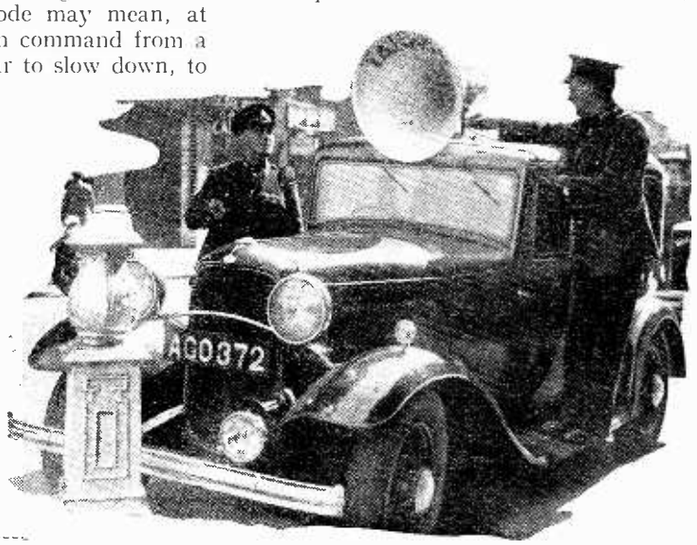
The Voice of the Law—

highly trained men will certainly make capital out of the idea.

Already they are trying the salutary effect of loud-speaking their admonitions to recalcitrant motorists on the roads. In this they are adding a new terror to motoring, one imagines. A slight deviation from the Highway Code may mean, at any moment, a sudden command from a following PA police car to slow down, to stop cutting-in, to get off the crown of the road, or, in a bad breach, to pull in and pull up to await the wrath to come.

It is intended that the modern policeman should act more as a corrective influence than as yet another agency for hounding the motorist into the police courts. The running commentary from a PA car is calculated to have just the desired effect.



PA-equipped police car "tunes up" before going on duty.

As an official pointed out to me, it is not always possible for a police car to show a motorist the error of his ways at the time he is actually at fault owing to congestion on the road and to the danger of the police car drawing level with or passing the offender. With public-address equipment this handicap will no longer apply.

Not only in London and on the highways, but in the great provincial cities, the PA-equipped police van is being developed. Wherever large crowds are apt to forgather, the loud-speaking police officer will eventually have his say.

At the recent Crystal Palace fire, for example, the crowds became so dense that human life was often endangered. The PA-equipped vans came to the rescue and effectively controlled the crowds as well as helping to sort out the chaotic muddle of motor vehicles.

The police themselves are all in favour of PA equipment to help them control crowds. A Marconiphone engineer was telling me that on the day of Princess Marina's wedding the police took over the Marconiphone PA-equipped coach in Horse Guards' Parade.

There was, apparently, a dangerous concentration of people at one point. Only the timely warning of the voice of authority, made even more commanding through the agency of the PA equipment, saved a situation that would have inevitably produced a crop of casualties.

The police have a special control box of their own at the Arsenal football ground, where officers can effectively control the influx of the spectators through the various turnstiles. I understand that some of the policemen who are eventually chosen to assume the rôle of announcers on the road are first grounded in their job at the Arsenal post.

From what I have myself seen of the vans in action I should say the police enjoy themselves at the microphone. Indeed, if this were the time and place, I could quote a collection of remarks that, for sheer light comedy, would certainly not be out of place in a B.B.C. variety programme.

What the policeman said at the Haymarket during the Jubilee is, in any case, immortalised, for the B.B.C. van faithfully recorded every word. I have no doubt the discs remain in the B.B.C.'s archives as historic proof, if any be needed, that our policemen are wonderful.

The Radio Industry

AN AC mains transportable has just been introduced by Lissen at the low price—for this type of set—of ten guineas. The receiver operates on a built-in frame aerial and the cabinet includes what is described as a balanced sound chamber.

A contract for four 10-kilowatt short-wave transmitting stations has been awarded to Philips Radio by the All-India Radio organisation. The stations will ultimately work on wavelengths between 30 and 90 metres.

The Belling-Lee exhibit at the British Industries Fair (Birmingham section, Stand Cb 724) will demonstrate the possibilities of interference suppression from many aspects.

Ekco will be represented at the British Industries Fair in both the London and Birmingham sections (Stands F.846 and Cb 926 respectively).

Components manufactured by the Premier Supply Stores will be exhibited on Stand No. 1945 at the B.I.F.

All Exide HT accumulators will, in future, be fitted with an anti-leakage shield for each terminal. An air gap is provided between terminal and shield.

Mr. W. A. Boucher, managing director of the well-known radio firm of Spedding, Ltd., Auckland, New Zealand, is due to arrive in London on February 19th for the purpose of attending the British Industries Fair. Mr. Boucher hopes to meet manufacturers who desire to extend their activities to New Zealand. His London address will be c/o Andrew Weir and Co., Ltd., 21, Bury Street, London, E.C.3.

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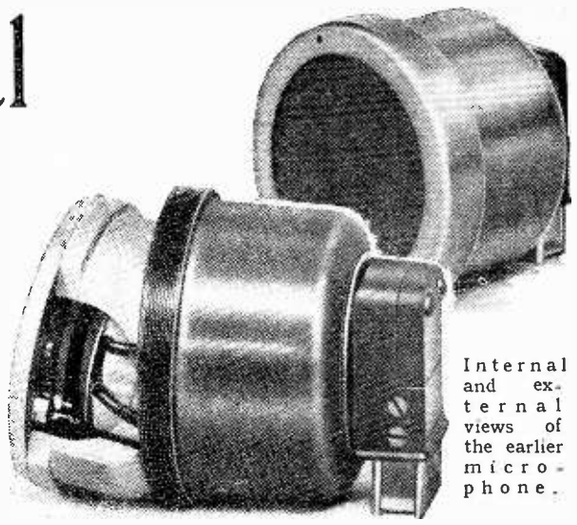


Internal and external views of the earlier microphone.

THIS article describes the development by the Bell Laboratories of a new non-directional microphone manufactured in this country by Standard Telephones and Cables, Ltd. (Type No. 4021-A). This instrument gives a sensibly level response up to 10,000 c/s for all angles of incidence.

EVER since the earliest days of the telephone art, attempts have been made to utilise the electro-mechanical force of a coil in a magnetic field for the purpose of converting sound waves into electrical currents and vice versa.

It is noteworthy that the development of such means for converting electric currents into sound waves advanced more rapidly than means for reproducing sound waves as corresponding electrical oscillations.

The earliest moving-coil microphones were very cumbersome and required a powerful energised magnet to provide the strong magnetic field required.

The development of cobalt magnet steel made possible the moving-coil microphone with a permanent magnet; and this, combined with the technique of the manufacture of very thin pressed aluminium alloy diaphragms and coils of aluminium tape wound edge-on, developed by the Bell Laboratories in America, led to the production, in 1931, of a highly successful moving-coil microphone.

The moving-coil microphone produced in 1931 was based on a careful design of the masses and stiffnesses of the moving system, and acoustic resistances formed of narrow, adjustable slots were incorporated in the microphone in order to render its response substantially flat. Another patented feature introduced into the microphone (which may also be applied to loud speakers) was the provision of a tube connecting the space behind the diaphragm with the front of the case.

This tube is of such a length that sound waves reach the rear of the diaphragm through it with a phase shift such that reinforcement of the acoustic pressure between the front and back of the diaphragm takes place, and the response of the microphone for frequencies below 200 c/s is from 1 to 6 db. better than without the tube.

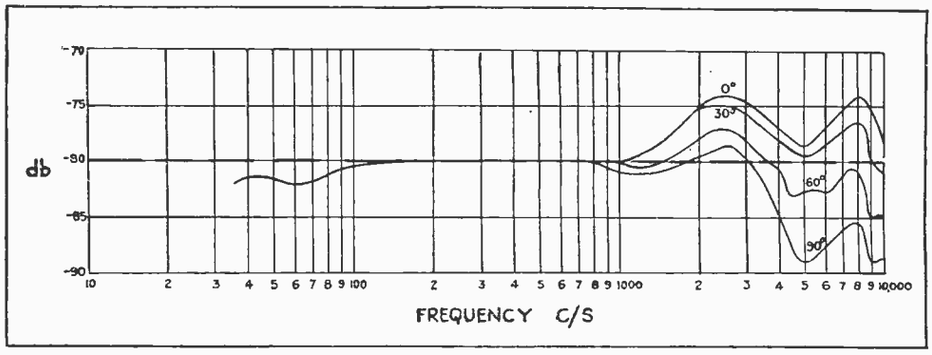
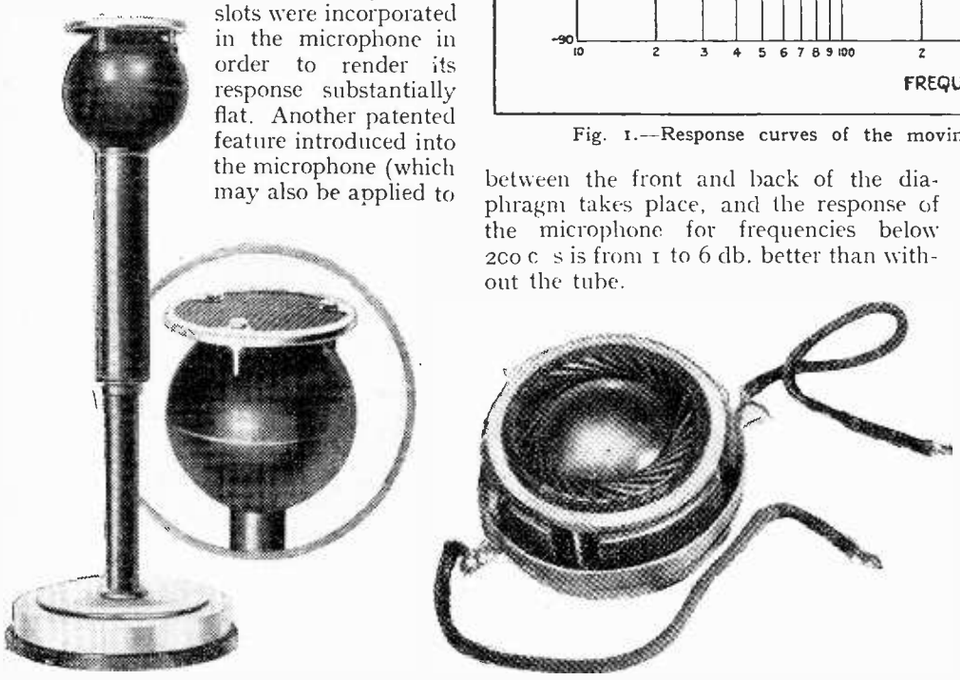


Fig. 1.—Response curves of the moving-coil microphone introduced in 1931.



The new microphone on its stand. The inset shows the gauze cover under which the acoustic screen is mounted. The magnet unit, shown approximately full size, is seen on the right.

The moving-coil microphone was designed to avoid noise due to the wind when used out of doors. It was also inconspicuous as compared with a condenser microphone and its necessary pre-amplifier, and very much more robust.

Very large numbers of these moving-coil microphones have been made during the past five years in England as well as in America, and they are now familiar sights at many public gatherings.

Having developed a microphone with a substantially uniform response, attention was directed to the production of a microphone which should have a uniform response for sound incident upon it from any direction.

The importance of having a microphone with uniform response for all angles of incidence lies in the fact that, in a broadcasting studio or any enclosed space, sound reaches the microphone not only directly from the performer, but also after reflection from the ceiling, walls and floor, as well as from objects in the room. If there is any variation in the shape of the response curve for different angles of incidence, then the reflected waves will be reproduced in a different way from the direct waves, and distortion will result.

It is unfortunate that there is some confusion in the interpretation of the term "non-directional." This adjective is applied equally to the microphone which has an equal response for any one frequency for any direction, the response curves taken for different directions being

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Non-Directional Microphone—

coincident, and to the microphone which has one or two directions for which the response is a maximum and other directions for which the response is substantially zero, but for which the frequency characteristics for other directions lie parallel over the frequency range of interest to the curve for the direction for maximum response. The new microphone is of the former class.

The fact that the response of the moving-coil and condenser microphones varied in accordance with the angle of incidence of the sound waves was well known. In fact, the response of the moving-coil microphone for various angles of incidence was plotted and published in the original paper in the *Journal of the Society of Motion Picture Engineers*, in which the microphone was first described. This curve is reproduced in Fig 1.

It was recognised, of course, that the diffraction effect was a function of the size and shape of the microphone, but with the moving-coil of one-inch diameter wound with aluminium tape a few mils wide it might have been supposed that the limit had been reached in manufacture.

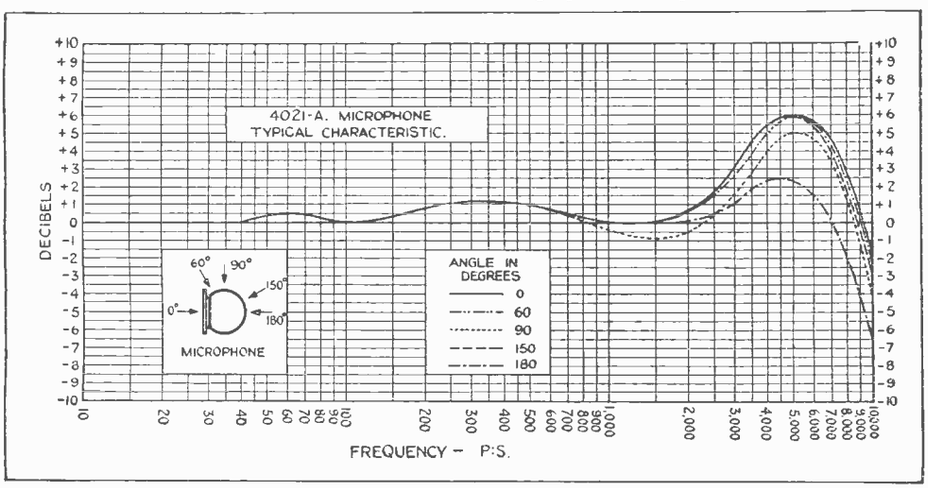

Fig. 2.—Response curves of the new directional microphone for five angles of sound incidence.

In spite of this a new Western Electric microphone was designed by the Bell Laboratories which used a diaphragm one inch in diameter, the coil being of $\frac{3}{4}$in. diameter, the thickness of the diaphragm being approximately that of tissue paper. Calculation shows that the spherical shape chosen for the housing is the best for minimising diffraction effects. An ingenious acoustic screen, invented by F. F. Romanov, placed in front of the diaphragm attenuates the high-frequency sound waves arriving along the axis of the diaphragm, and acts as a reflector for waves incident from behind the microphone.

In some cases it is desirable that the microphone should not respond equally to sound incident from all directions. To meet these requirements, an acoustic baffle may be fitted in place of the acoustic screen. This can easily be done without disturbing the inside of the microphone by removing three screws which hold the acoustic screen in place, the change being made in a minute.

The new non-directional moving-coil microphone has found favour with European Broadcasting authorities, and is being manufactured in this country by Standard Telephones and Cables, Ltd.

BOOK REVIEW

SOS. By Karl Baarslag. Pp. 243, 12 plates. Published by Methuen and Co., Ltd., 36, Essex Street, London, W.C.2. Price 10s. 6d.

IN these days when, to the average man, the chief use of wireless seems to be to provide entertainment, there is a great danger that its earliest function—which is still one of its most important ones—namely, the saving of life at sea, may be almost entirely forgotten. The appearance of this book, therefore, is highly appropriate since it deals in a very thorough manner with all the more important maritime disasters in which wireless communication has been the means of saving many hundreds of lives.

A graphic word-picture is drawn of the great *Titanic* disaster of 1912, while the less-known tragedies of the *Empress of Ireland*, the *Volturno* and the *Morro Castle* are described with a great wealth of detail, together with many others which are scarcely less absorbing to the reader.

Apart from its main subject, the book gives us a very clear insight into the early history of wireless telegraphy, especially from the point of view of its use on board ship, and it is interesting to learn that the first wireless distress calls from a ship were sent out as long ago as *March 3rd, 1899*. It is rather unfortunate that the author omits to deal with the epic stories of the War period, including the sinking of the *Lusitania*, but probably he thought that they deserved a book of their own, and it is earnestly to be hoped that he will turn his attention to the writing of it.

N. P. V.-M.

New Output Valve

A NEW valve of the pentode type is announced by Mullard. It is the Pen.428 and is intended for use where large output is required. With 250 volts applied to the anode and screen an output of 8 watts for 10 per cent harmonic distortion is claimed, operating under Class "A" conditions. The price is 25s.

A pair of these valves in push-pull Class "AB" will deliver 28 watts for only 3 per cent. distortion. An anode potential of 375 volts with 275 volts applied to the screen is then needed.

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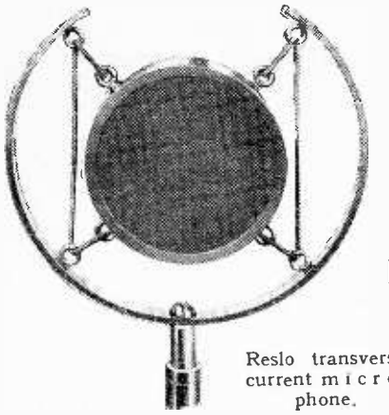
Microphones

CARBON, MOVING-COIL, RIBBON AND CRYSTAL TYPES



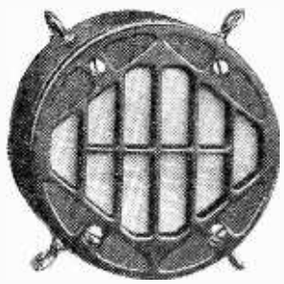
Reslo transverse current microphone.

THERE can be little doubt that the carbon microphone has many advantages to justify its undoubted popularity with manufacturers of PA equipment. It is sensitive and has an admirable frequency characteristic, particularly when of the transverse current type.

The Parmeko Type JM1, the Reslo Type LC, the Shaftesbury "Bio-Tran," and the Trix carbon microphone, are excellent examples of this form of construction. In the "Vari-Dep" transverse current microphone made by the Telephone Manufacturing Co., Ltd., the granular layer is shallower at the centre than at the sides, the object being to overcome defects due to variation in the penetration of sound waves at different frequency.

In the Philips carbon microphone there are three ring electrodes which are gold plated. The centre and outer rings are taken to one pole and the intermediate ring to the other pole of the battery. The output is 60 millivolts for a pressure of 1 dyne per sq. cm. (i.e., one bar). A series of adaptation boxes incorporating suitable transformers are available. Volume control is effected by a potentiometer across the secondary in order to maintain a constant polarising current, and a tone control is arranged to give a variable bass cut-off to increase intelligibility when necessary. The range of Philips microphones also includes lapel and hand types. A carbon type lapel microphone is also made by W. Bryan Savage.

The carbon microphones used in the Marconiphone PA equipment are built to the well-known Reisz specification. In the G.E.C. Type BCS1575 a slate body is employed in conjunction with a mica diaphragm. It has a sensitivity of 12 millivolts per bar at 1,000 cycles and a DC resistance of 250 ohms. The G.E.C. lapel microphone is also of the transverse current type. It measures $1\frac{3}{4} \times 1\frac{1}{2} \times \frac{3}{4}$in. and weighs 1oz. The sensitivity is 10 millivolts per bar.



T.M.C. "Vari-Dep" transverse current microphone.

A useful general purpose microphone is marketed through the Ediswan-B.T.H. organisation. A moulded case forms the backing for the granules, and the instrument is rubber-suspended in a cellulose black enamel stand. Inexpensive hand type microphones are also available from Scientific Supply Stores and Microphone Equipment, while a microphone of the transverse current type built to a design described in this journal and housed in an octagonal polished aluminium case is marketed by M.R. Supplies.

Microphones of the moving-coil type have the advantage of robustness and a very low level of background noise. The Types TV/55 and TV/56 of Truvoice, Ltd., and the Epoch Model 55 are good examples of this type. The latter is fitted with an Alnico magnet and has a frequency response from 70 to 5,000 cycles. The sensitivity is —85 db., zero level being indicated by an output of 1 volt for a pressure of 1 bar.

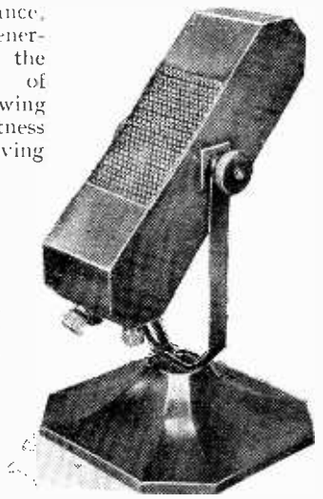
Wharfedale moving-coil hand-type microphone.

A cone of non-hygroscopic material is used in the Grampian moving-coil microphone, and the aluminium-wound speech coil has an impedance of 14 ohms. In the G.E.C. microphone an aluminium coil is again used and the light bakelised paper cone is mass-controlled with a very low main resonance. The sensitivity is —54 db., or 2.1 millivolts per bar.

The construction of the Reslo moving-coil microphone is interesting for the method which has been adopted to centre the aluminium-wound coil. A concentrically ribbed disc of special material having a cellular structure permits circulation of air between the two sides of the disc. The characteristics of the Tannoy Type T streamline microphones are improved by incorporating the movement in a torpedo-shaped bronze body.

The Wharfedale microphones work on the moving-coil principle and are available alternatively with 2-ohm or 15-ohm coils. They are enclosed in light aluminium cases, the hand type being finished in brown and the stand type in black and chromium.

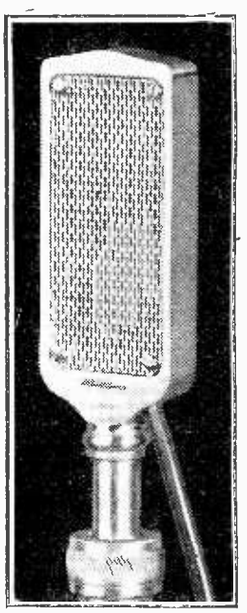
The ribbon microphone is virtually a moving-coil microphone in which the coil consists of a part of one single turn. The great advantage is that the ribbon can be made so light that the normal air-damping controls the main resonance, which is generally near the lower limit of audibility. Owing to the lightness of the moving part the high-frequency response is also extremely good.



Shaftesbury "Velodyne" ribbon microphone.

In the Philips ribbon microphone the aluminium strip is $\frac{3}{16}$in. wide and only 0.00015 inch thick. The sensitivity is —76 db., and a special pre-amplifier has been developed giving an over-all characteristic for amplifier and microphone linear from 60-10,000 cycles within 0.5 db., and with a rise of 2 db. down to 30 cycles.

The Grampian ribbon microphone has the high sensitivity of —53 db., and the frequency response is given as 30-16,000 cycles. The Shaftesbury "Velodyne" microphone makes use of four parallel ribbons connected in series. It has a frequency response from 50-10,000 cycles and a sensitivity of —45 db. The transformer is designed to match a 200-ohm line.



Rothermel-Brush Type B2S "sound cell" microphone.

Microphones of the piezo-electric type are now firmly established for PA work, and in addition to having a negligible background noise level they have a remarkably good frequency characteristic, particularly when of the "sound cell" type. In this category one of the best examples is the Type G456P, marketed by R. A. Rothermel, Ltd. The character-

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Microphones—

istic of this microphone is flat from 40-6,000 cycles, and then rises slightly to 10,000 cycles. The sensitivity is 68 db. Another type is the B2S shown in the accompanying illustration. It has a similar frequency characteristic, but the arrangement of the sound cells is slightly different. This microphone is also available in a spherical case (Type BR2S). The Type T2S4P is mounted in a sloping container especially designed for installation near the footlights for theatre sound reinforcement systems.

M.R. piezo-crystal microphone.

The piezo-electric microphone made by MR Supplies incorporates a diaphragm-driven movement hermetically sealed in a housing turned from Magnesian stone and fitted with a chromium bezel, which in conjunction with the colour of the body has a very effective appearance. W. Bryan Savage market two types of piezo-electric microphones, the PA 100 and the Type DPA/D. The latter has a diaphragm movement and is fitted in a desk type stand.

Finally, we come to condenser microphones, of which the Voigt slack diaphragm type is a well-known example. The Radio Development Co., Ltd., have also added a condenser type to the Epoch range of microphones. This microphone should be regarded as a unit with its built-in pre-amplifier, and the combination has an overall response flat within 3 db. from 50-10,000 cycles. The filament supply is 6 volts, and the HT and domestic potential is 180 volts. The output impedance is 200 ohms.

Club News

The Harco Radio Club (Greenwich)

This society holds meetings every Tuesday at 8 p.m. in the canteen lounge of G. A. Hardy and Co., Ltd., Woolwich Road, Charlton, London, S.E.7, to which all interested are cordially invited. Morse classes and the testing of members' receivers figure among the club's many activities. The Hon. Secretary, who will gladly furnish full details of the society's activities, is Mr. C. W. Kemp, 124, River Way, Greenwich, London, S.E.10.

The Radio Physical and Television Society

The first lecture of the second half of the winter session was given by Mr. J. G. Hobbs, his subject being "Short-Wave Converters and Superheterodyne Receivers." The interest of the lecture was enhanced by demonstrations on an all-wave receiver lent by Messrs. Burgoyne, Ltd. The society holds meetings at 72a, North End Road, W. Kensington, London, W.14, every Friday during the winter months. A big effort is being made to increase membership and those interested are invited to write to the Asst. Hon. Secretary, Mr. V. R. Walker, 19, Fitz James Avenue, London, W.14.

Television Programmes

The system to be used each day is given below the date. Transmission times are from 3-4 and 9-10 daily.

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FRIDAY, FEBRUARY 5th.
(Marconi-E.M.I.)

3, "Pastiche"—a floor show with the B.B.C. Television Orchestra. **3.20,** Gaumont British News. **3.30,** Accidents in Sport: Practical Demonstration of First Aid by the St. John Ambulance Brigade. **3.45,** Margaretta Scott as Rosalind in scenes from Shakespeare's 'As You Like It."

9, Scenes from Shakespeare's "King Henry V" with Yvonne Arnaud (Katharine), Henry Oscar (Henry V) and Marie Mervin (Alice). **9.15,** Repetition of 3.30 programme. **9.30,** British Movietonews. **9.40,** Repetition of 3 programme.

SATURDAY, FEBRUARY 6th.
(Marconi-E.M.I.)

3, "The Tinder Box"—a fairy story told by Harcourt Williams. **3.10,** Ju jitsu demonstration. **3.20,** British Movietonews. **3.30,** Variety.

9, Interview with Lilli Palmer, the twenty-one-year-old Viennese film star. **9.10,** Repetition of 3.10 programme. **9.20,** Gaumont British News. **9.30,** Extracts from a cabaret now running in the West End.

MONDAY, FEBRUARY 8th.
(Baird.)

3, Prize Dogs to be exhibited at Crufts Dog Show. **3.15,** British Movietonews. **3.25,** The World of Women—III. Painting and Pottery discussed by Dame Laura Knight. **3.40,** Film. **3.50,** Starlight.

(Monday, February 8th—*continued.*)

9, Repetition of 3 programme. **9.15,** Gaumont British News. **9.25,** Repetition of 3.25 programme. **9.40,** Film. **9.50,** Cabaret.

TUESDAY, FEBRUARY 9th.
(Baird.)

3, Forecast of Fashion—display of dresses for the daytime. **3.15,** Gaumont British News. **3.25,** Variety.

9, Repetition of 3 programme. **9.15,** British Movietonews. **9.25,** Variety.

WEDNESDAY, FEBRUARY 10th.
(Baird.)

3, London Galleries—Second of series of talks on the current exhibitions of pictures and sculpture. **3.15,** Film. **3.25,** Twenty-seventh Picture Page. **3.50,** British Movietonews.

9, London Galleries—Third of series of talks. **9.15,** Gaumont British News. **9.25,** Twenty-eighth Picture Page. **9.50,** Film.

THURSDAY, FEBRUARY 11th.
(Baird.)

3, Henry Oscar as Mark Antony in scenes from Shakespeare's "Julius Cæsar." **3.10,** Home Affairs—III. John Hilton. **3.25,** Gaumont British News. **3.35,** "Café Cosmopolitan," produced by Dallas Bower.

9, Margaretta Scott as Beatrice and Henry Oscar as Benedick in scenes from Shakespeare's "Much Ado About Nothing." **9.10,** Repetition of 3.10 programme. **9.25,** British Movietonews. **9.35,** Repetition of 3.35 programme.

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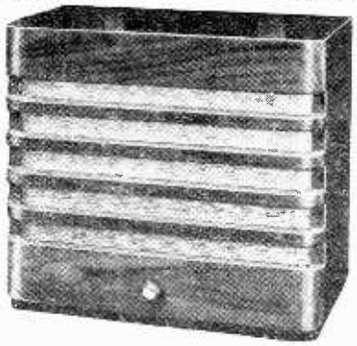

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Valves in PA Equipment

HIGH-POWER OUTPUT STAGES

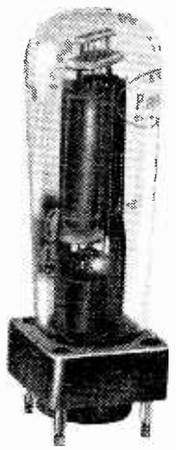
THE most obvious difference between PA equipment and an ordinary AF amplifier lies in the output stage, for much greater output is naturally needed. For public address purposes an output of some 30 watts is usually considered the minimum, and there are two entirely distinct methods in common use of obtaining this. One is to employ a large output stage, the other to use a number of small ones.

The latter course is widely adopted and the equipment consists of a number of quite separate amplifiers, each having an output of some 12 watts. An output of this order is easily obtained from a pair of PX25, PP5/400, DO24 or similar valves operated in push-pull. The amplifiers are arranged so that the inputs and outputs can be paralleled and so feed a group of loud speakers, or each amplifier can feed only one or two speakers.

The advantage of this arrangement is that should a defect occur in any amplifier the whole equipment is not thrown out of action, for the remaining amplifiers can carry on at somewhat reduced power while the defective one is being put right. Moreover, it makes a flexible installation which is particularly suited to PA contractors who have to make provision for widely varying conditions. One day's work, for instance, may be done satisfactorily with a modest output of 20 watts or so, whereas at another time four or five times this figure may be necessary.

(Left) The Osram DA30 output valve and (above) the GU5 rectifier.

For permanent installations, however, the single channel type of equipment is more often adopted, and it is then necessary to include a large output stage, the minimum normally required being some 30 watts. It is quite possible to secure an output of 30 watts from a pair of valves operated in push-pull and one possibility is to use PX25A valves in the "low-loading" circuit.[1] An HT supply of no more than 500 volts is necessary and the circuit diagram is of conventional type, the unusually large output being obtained not with the aid of some freak circuit but by the adoption of special operating conditions for the valves. Still greater output can be secured from this system by using larger valves and with two DA30 valves no fewer than 44 watts can be secured with an HT supply of 500 volts.



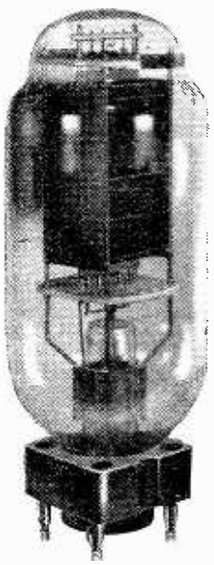
The Tungsram P60/500.

Large output valves of this type are not always well adapted to the positive drive of the Class "B" system, for it is often dangerous to valve life to permit grid current. When using the DA30 valves it is necessary to connect a diode across the input circuit in order to prevent a dangerously high positive voltage being applied to the grid during a momentary overload.

The "low-loading" system demands suitable types of valve and is of little benefit with some specimens. There are many cases, therefore, where ordinary operating conditions are adopted and large valves employed. A single valve of the DA60, MZ05-60, 660T, K450/50 class will give out some 10 watts, so that a pair in push-pull might reasonably be expected to deliver an output of some 25 watts or more. Even larger valves are available, and it is possible to obtain 30 watts from a single valve such as the PP100/1,000 with an anode dissipation of 100 watts; the HT supply is then usually about 1,000 volts, however.

In order to avoid such a high voltage it is more usual to employ push-pull, and to reduce to a minimum the power supply use is often made of Class "B" systems in spite of the greater difficulty of obtaining distortionless reproduction. By adopting this system surprisingly large outputs can be secured from small valves.

Two of the American 6L6 valves[2] run in Class "AB," that is, a condition approaching quiescent push-pull will give an output of 34 watts with only 2 per cent. distortion and with an HT supply of 400 volts. The anode current is necessarily fluctuating, but only between the limits of 100 mA. and 152 mA. Still greater output can be secured by operating them in Class "B," and no fewer than 60 watts can be secured still with only 400 volts HT. The peak current consumption, however, is 250 mA., and the fact that grid current is permitted necessitates very careful design of the driver stage if distortion is to be avoided.



(Above) The Ediswan ES100 output valve and (left) the Tungsram P100/1000.

Larger valves are often used in Class "B," however, and if suitable types are selected the necessary positive drive is not detrimental to valve life. For large output two DA100 valves may be used at 1,000 volts anode potential, and no fewer than 200 watts output obtained for 4 per cent. harmonic distortion. The anode current consumption at full load is 300 mA., and 250 volts peak input is needed. This must be obtained from a pair of push-pull PX25 valves in the driver stage with cathode coupling, and these in turn require a pair of push-pull ML4 type valves to provide their input.

Rectifiers

When large output stages of this type are needed the mains equipment must be carefully designed and a mercury rectifier such as the GU5 is adopted. This valve is capable of an output of 500 mA. at 1,000 volts, but as it is a half-wave rectifier two are usually employed to give full-wave rectification.

The difficulties of PA equipment are by no means confined to the output stage, however, for in some cases the input stage can be even more troublesome. When an insensitive type of microphone is employed, such as the ribbon or condenser types, a very high degree of amplification is necessary and valve noise in the first stage becomes very important. Several valve makers have introduced special types of valves for such cases, and the MH40, A537 and V312 are examples of these. Such valves cost considerably more than ordinary types and have similar characteristics. They are characterised, however, by a special construction which renders them much less microphonic and gives them a lower inherent noise level.

Where sensitive microphones of the carbon type are adopted, of course, no difficulties arise in the input stage, and it is for this reason that they are so widely used in spite of their inferior characteristics from a quality point of view.

[1] *The Wireless World*, March 15th, 1935.

[2] *The Wireless World*, January 1st, 1937.

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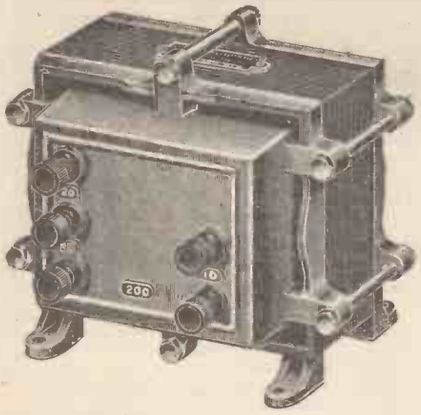

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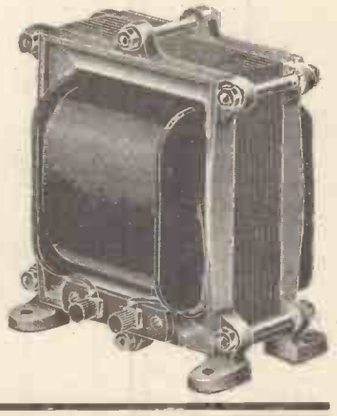

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THE BALDWIN INSTRUMENT COMPANY BEGS TO ANNOUNCE THAT AS PROPRIETORS OF

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THEY ARE PREPARED TO CONSIDER THE GRANTING OF LICENCES FOR THE MANUFACTURE OF LOGARITHMIC POTENTIOMETERS COVERED BY THE ABOVE PATENT:

Legal proceedings will be taken against any person or firm making or selling apparatus that infringes the above patent.

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Amplifiers and P.A. Equipment

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P.A. EQUIPMENT.
AMPLIFIERS.
RADIO CHASSIS for all purposes.
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If you want P.A. Equipment that gives true high fidelity reproduction, you must have B.S.R. which is designed for this purpose.

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TANNOY

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G.M. 15a. "IDEAL" Trader's Amplifier (illustrated below).
Undistorted output 20 watts
High gain 94 db
Low hum level – 70 db
Operation from A.C. mains, 200/250 v. 50 cycle
An ideal amplifier embodying unique features and with an output adequate for the majority P.A. requirements.
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G.U.B. 10. A popular universal amplifier, operated from A.C., D.C. or car battery without alteration.
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Equipment with a Reputation for Reliability and Quality

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M. 15. This amplifier is identical with the G.M. 15a and c., except that no gramophone turntable is provided and control panel is simplified.
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A 3-stage High-Gain Amplifier with push-pull output.
The input valve (Type 77) is resistance-coupled to the second valve (Type 76) which is in turn Transformer-coupled to two Pentodes (Type 18) in Push-Pull, giving 7 watts output.
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PRINCIPAL DETAILS OF SPECIFICATION :—

INPUT: 200 / 250 volts A.C. or D.C.

OUTPUT: 8 watts undistorted speech.

AMPLIFIER: Celestion super quality fitted with tone and volume control, terminals for gramophone pick-up and provision for use of extra loudspeaker.

MICROPHONE: Highly sensitive moving coil type with wide angle pick-up.

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TYPE BR.1 **19** GNS.

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Officially approved by H.M. Office of Works, War Office, L.C.C. School Broadcasting Council, and other Authorities.

Send now for details of all models—amplifiers, microphones, speakers. It will pay you to have our quotation.

Model T262 Amplifier 20/25 Watt, high gain **£26.0.0** *Portable type, as illustrated, £3.0.0 extra.*

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'Phone: Clerkenwell 3014/5.

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PUBLIC ADDRESS OUTFIT

Designed to enable those with only superficial technical knowledge to give first-class entertainment to crowds of up to 12,000 people.

- **RADIO reproduction to relay the Coronation ceremony.**
- **GRAMOPHONE music to give zest to the festivities.**
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The equipment includes suitable cables and connections, all of which are non-interchangeable so that it is impossible to make a mistake.

THERE ARE ONLY FOUR SIMPLE CONNECTIONS TO MAKE!

ORGANISERS OF CELEBRATIONS *are invited to consider the advantages of purchasing this outfit as a*

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WIRELESS DEALERS *are asked to investigate the merits of this amazing equipment built on precision engineering lines by the foremost experts in the manufacture of HIGH QUALITY Sound Systems ONLY.*

★ Write for full particulars of the Coronation Outfit and also Brochure describing some interesting ARDENTE Installations.

ARDENTE technicians were responsible for the mammoth Public Address installation erected at Southport last year covering an area of nearly one square mile. JANUARY contracts include

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and many large installations for local authorities all over the country.

Among PERMANENT INSTALLATIONS being fitted by ARDENTE this month are included :—

A BLOCK OF 80 FLATS IN BRIXTON—Dual Channel Wireless Distribution System.
THE NEW RINK, SUNDERLAND—High Power Amplifiers and 24 Loudspeakers.
BLACK'S REGAL THEATRE, GATESHEAD - ON - TYNE—Stage Amplification.
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Cash In *on the Coronation* ★ *with*

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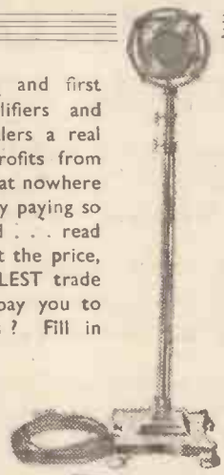
The low price, generous discounts, and first class performance of F.D.H. Amplifiers and P.A. Equipment give progressive dealers a real opportunity to make worth-while profits from P.A. Contracts. It is our conviction that nowhere else will you be able to get so much by paying so little. Look at the Amplifier illustrated . . . read the specification . . . and then look at the price, which by the way is subject to FULLEST trade discounts. Don't you think it will pay you to learn more about F.D.H. Amplifiers? Fill in the coupon and post NOW.



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16 GNS Retail (*Subject*)

Also supplied with Gramophone Desk

22 GNS Retail (*Subject*)

F.D.H. make Amplifiers for any and every purpose. An Advising Bureau is at your disposal—ENTIRELY FREE—to assist you in your P.A. problems. Please make use of it.

★ *and not only the Coronation but for all time*

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Without obligation send me full details of F.D.H. Amplifiers together with discounts.

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CORREX HIGH GRADE Sound REPRODUCING EQUIPMENT for every purpose.

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1937 PRE-AMPLIFIER UNIT
TO YOUR OWN RECEIVER
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SCORES OF EXTRA PROGRAMMES

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One plug to mains.
One plug to set.
No alterations.
No technical knowledge required.
Stations are tuned in as easily as on broadcast wavelengths.

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One switch covers 10-115 metres.
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Calibrated and illuminated dials.
Dozens of extra programmes are obtainable at local station strength.

Model F1.
A.C./D.C. Mains.
Self contained.
Power Pack 79/6 (Less Valves).
Model AF3. For A.C. Mains Sets.
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A FARREX UNIT WILL MAKE YOUR OWN SET ABSOLUTELY UP TO DATE, AND GIVE YOU
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ASK YOUR DEALER ABOUT THIS AMAZING UNIT.

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A GREAT P.A. ADVANCE!

Larger output
Lower anode voltage
with
The MULLARD PEN. 428

A new development in pentode design, providing 8 watts power output at an anode voltage of 250 v.

OPERATING DATA.

Heater voltage	4 volts.
Heater current	2.1 amps.

CLASS A OPERATION (single valve).

Anode voltage	250 volts.
Screen voltage	250 volts.
Power output	8 watts.

CLASS A.B. OPERATION (two Pen. 428).

Anode voltage	375 volts.
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Power output	28 watts.

Full details and circuits on request.

25/-

Mullard

Mullard Wireless Service Co. Ltd., Mullard House, 225, Tottenham Court Road, W.1.

C.V.S. 72

TUNGSRAM for P.A.

Their extreme reliability is a big feature of Tungsram's range of valves. This range extends from 12 to 250 watts anode dissipation and includes valves suitable for all purposes of high fidelity audio work.

Also available are valves for the early stage of microphone or sound head amplification. These valves are guaranteed, and are of an extremely robust construction, with unusual rigidity, have extremely high vacuum, giving long and consistent life. There are over two hundred Tungsram types available for all purposes, including equivalents to U.S.A. types.

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Barium **VALVES**

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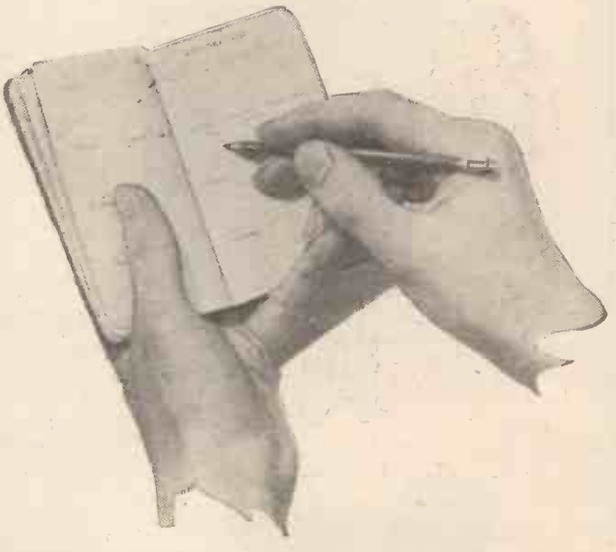
The **Wireless World**

DIARY FOR 1937



Every wireless enthusiast should have this handy little diary. In addition to the usual pages—one week at an opening—it contains 76 pages of facts, formulæ and general information of the kind that is always wanted but is difficult to memorise.

There is a complete list of European Broadcasting Stations and Short-wave Stations of the World. In addition an important section contains all the recognised codes relating to components, as well as useful tables of resistance ratings. There are also nine pages of base connections of British and American valves.

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Let us quote for your requirements—full details on request.

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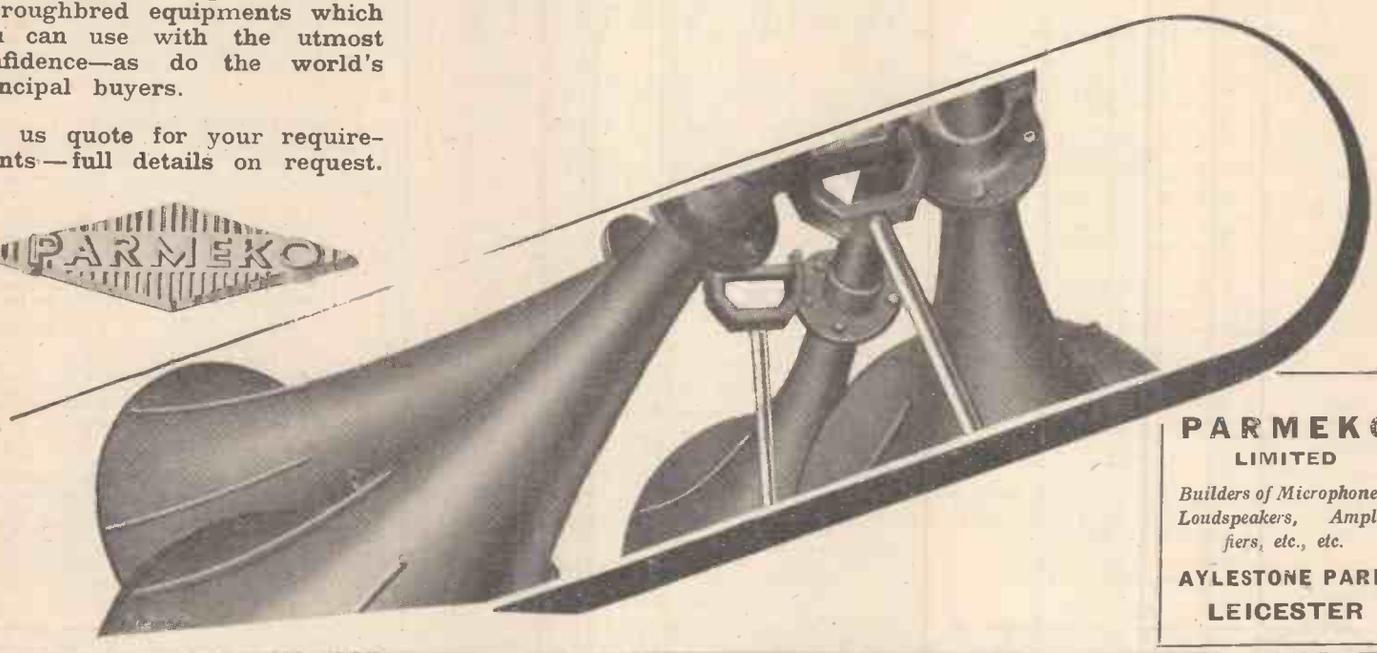

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THE WATERHOUSE UNIVERSAL U.8 PORTABLE AMPLIFIER

OUTPUT **8** WATTS.
PRICE **18** GUINEAS.

This Waterhouse production is another example of modern design applied to portable amplifiers. The complete outfit measures only 13½ × 14½ × 8½ ins., while the weight is only 35 lbs. The case contains an 8-watt chassis for operation from either A.C. or D.C. mains. The microphone is neatly and securely fastened in the case together with the P.M. speaker and a folding polished baffle to which it is securely fixed when in use.

QUALITY AMPLIFIERS from 8 to 90 WATTS U.D.O.
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"Wide Range"
Complete with operator available for functions where MICROPHONE ANNOUNCEMENTS MUSICAL SELECTIONS are required for HIRE or PERMANENT INSTALLATION.
Consult us for Advice FREE.

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"Two-Inch" Projection LOUDSPEAKER

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Neat
Efficient
Blends with furnishings
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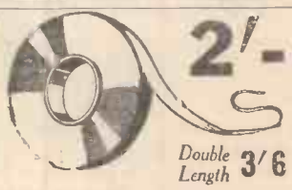

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ADVERTISEMENTS for these columns are accepted up to FIRST POST on MONDAY MORNING (previous to date of issue) at the Head Offices of "The Wireless World," Dorset House, Stamford Street, London, S.E.1, or on SATURDAY MORNING at the Branch Offices, 19, Hertford Street, Coventry; Guildhall Buildings, Navigation Street, Birmingham, 2; 260, Deansgate, Manchester, 3; 26B, Renfield Street, Glasgow, C.2.

Advertisements that arrive too late for a particular issue will automatically be inserted in the following issue unless accompanied by instructions to the contrary. All advertisements in this section must be strictly prepaid.

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All letters relating to advertisements should quote the number which is printed at the end of each advertisement and the date of the issue in which it appeared.

The proprietors are not responsible for clerical or printers' errors, although every care is taken to avoid mistakes.

NEW RECEIVERS AND AMPLIFIERS

A

A

DEGALLIER'S, Ltd., the Firm for Reliable Short Wave Radio (1937), have on show in London the largest selection of fully guaranteed brand new all-wave receivers; callers invited to handle all at their leisure without obligation to purchase; all S.W. receivers guaranteed to get stations on the low bands, including the Americas, etc. Hours of business, 11 a.m.-7 p.m., Saturdays 9 p.m. Early closing day Mondays. All goods cash with order or c.o.d.; handsomely illustrated catalogues available; send large stamped addressed envelope with all enquiries.

WE Guarantee to Receive the American Transmissions at full programme strength after 3 p.m. daily; those interested welcomed without obligation.

6/6 Each.—Valves for American receivers, all guaranteed, each a first, no seconds or throw-outs; for every known set, from 1927-37; metal, metal glass, glass counterparts and glass; in ordering just state type and number; we have it; all post paid; line cords for all Midgets, 4/6.

30/-.—"Doublet" Aerial Belden No. 8917, complete ready to erect; the most efficient made, having a variable coupling unit covering all bands.

£3/10.—T.R.F. Midget Receiver. "The smallest of its type in the world," medium and long wavebands, moving coil speaker, 2 watts undistorted, no earth, no aerial; compact and transportable, cloth covered, and obtainable in various colours; carriage 1/6.

13 Guineas.—The new Challenger 8 (type 800) table model De Luxe, 22×18×12 high fidelity 8-valve superhet, A.C., 200-250 volts, wave-band coverage 11-2,050 metres, simplified centralised tuning, super Vernier, slow-fast tuning self-contained control panel, perfect tone quality at low volume, new type 10-inch M.C. speaker, from a whisper to 8 watts pure undistorted tone, no overloading at full volume, oscillator fundamental without use of harmonics, persistent oscillator of highest output, isolating filters eliminate oscillation and motor-boating, fully delayed A.V.C. bias, absolute minimum of noise and sensitivity control for noise suppression, A.V.C. re-enforced capacitators prevent drift, pre-aged intermediate frequency transformers, I.F. barrier, discs, anchor coil leads, plug in loud-speaker, also provision for external speaker, moisture sealed out by tropical zone impregnation, self healing electrolytic condensers, one complete chassis of dreadnought construction, moderate voltages assure full valve life, economical to operate (consumption 65 watts), long life eliminates repairs, correct valve selection, no compromise, no hum, full weight transformers, true push-pull, stabilised high tension supply, stabilised biases, ceramic coil insulation, fully loaded plate coils give maximum gain, pre-balanced coil assembly, matched sets of individual coils, no taps, sealed insulation, thin laminations of special silico steel, 7 K.C. selectivity, fractional microvolt sensitivity, shielded switching, permits high-gain, positive silver-plated contacts, eliminates switch noises, audio frequency range 30-8,000 cycles, diode detection, prizmatone high fidelity R.F. preselector stages on all bands, carriage, 6/-; for experimenters, less cabinet deduct 15/-; if public address Rola 12in. G.12 supplied in place of standard speaker, add £2.

(This advertisement continued in third column.)

HT

WAIT A LITTLE

before you buy a new set for getting stations: Hartley-Turner are getting ready something new. It is a

SUPERSONIC RECEIVER
WITH
HARTLEY-TURNER
QUALITY

We know that many enthusiasts for high fidelity believe that such a set can't be made. But we have done it.

Our new M.A. Super Receiver gets locals so well that only the keenest ear on the best transmissions can detect any difference from our well-known short-range S.A. set.

At the same time the M.A. Super will get all the main European stations. Selectivity is variable; the band-width may have to be cut in cases of severe "monkey-chatter"; but whatever the conditions, the M.A. Super gives *at least 25% better band-width for the same interference level*, compared with the usual modern "superhet."

This may seem a bold claim, but it is a just one. It is based on the fact that we use, not band-pass filters, but peak tuning and tone compensation.

The prices will not exceed:

7 watt output	..	£35 0 0
12 " "	..	£37 10 0

for chassis, complete with valves; and we have every expectation that they will be somewhat less.

Production starts soon. We give no promise of delivery *yet*. But we have a hand-made sample ready to demonstrate:

COME AND HEAR IT

A preliminary leaflet giving technical data is available.

HT

HARTLEY TURNER
RADIO LTD.,
THORNBURY ROAD,
ISLEWORTH, MIDDLESEX.
Telephone: HOUnslow 4488

NUMBERED ADDRESSES

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SPECIAL NOTE.—Readers who reply to advertisements and receive no answer to their enquiries are requested to regard the silence as an indication that the goods advertised have already been disposed of. Advertisers often receive so many enquiries that it is quite impossible to reply to each one by post. When sending remittances direct to an advertiser, stamp for return should also be included for use in the event of the application proving unsuccessful.

NEW RECEIVERS AND AMPLIFIERS

(This advertisement continued from first column.)

NOTE.—The Challenger 800 is available for A.C./D.C. 200-250 volts, employing 11 valves, at an additional cost of 20/- on each model.

CHALLENGER Model 381, 8 valve, 13-2,060 metres, Polychromatic dial scale, improved vision master, beam power output valve, 10 watts undistorted, band spread Magna dials and second-hand, magic eye tuning, full range, tone control, automatic band indicator, high image frequency suppression, hair line selectivity, ultra sensitivity; carriage 5/6; or in chassis form for the experimenter, chassis, dials and speaker, £13/18; the 381 is available in A.C. only, 100-250 volts.

£16.—Challenger 12 A.C./D.C. 200-250 volts, 4 bands 11-2,050 metres, the first time that D.C. users have been able to get 10 watts undistorted from their speaker, which is a large 12in. K. type Rola, triple parallel rectification, push-pull parallel four pentode output, carriage and crate 7/6.

£17/17.—Challenger 8 Console 800C., height 3 feet 6 inches, width 24 inches, depth 12½ inches, chassis as incorporated in 800 model but incorporating the G.12 high fidelity 12in. speaker; carriage and crate 10/-.

£20.—Crosley High Fidelity Console De Luxe, 10-valve, superhet., height 43½in., width 24in., depth 13in., 5 wavebands, 12-30, 30-75, 75-200, 200-600, and 750-2,000 metres, neon tuning, 12in. Magna "66" speaker, 12 watts undistorted output, separate oscillator valve, separate windings on I.F. transformers for improved selectivity, operates on A.C. 95-267 volts, 20-60 cycles, general specification as in 800 model; carriage and crate 10/-.

£33.—Radiogram with auto charger, incorporating same chassis as above, carriage and crate, 14/-; £16 chassis, valves and speaker, with all knobs and escutcheons, etc., carriage 6/-.

29 Guineas.—"Challenger 800 R.G." radiogram with automatic record changer; measurements, height 2 feet 8 inches, width 3 feet, depth 21 inches; this also incorporates the G.12 and tweeter; carriage and crate 15/-.

£50.—Challenger "Model 5240" 24-valve superhet. twin chassis, valve and "2" Public address speaker, with 60 watts undistorted output, sensitivity ¼ microvolt absolute, tuned H.F. stages on all bands, 3 I.F. stages, the last one being used for selectivity only, frequency response at the speakers within 2db over whole range, wave band coverage 5-2,050 metres in 5 bands, Magic-eye tuning, variable selectivity, receiver chassis heavily shielded and chromium plated, Centro-Master automatic control unit, dual rectifier, signal channel separate from A.V.C. system, linear, diode detection, separate rectifier to provide A.V.C. voltage, radio frequency pre-amplifier stages eliminate repeat points and whistles, and provide maximum signal to noise ratio, beam power output valves, polychromatic dial scale, prizmatone high fidelity, uni-control 2-speed free-wheeling tuning, band spread Magna dial and second-hand, automatic band indicator, automatic interstation noise suppression, separate bass boosting amplifier, automatic frequency control, iron core I.F. transformers, code interference filters, automatic volume control, beat frequency oscillator; carriage 18/-; also available in various gramophone and console cabinets.

DEGALLIER'S, Ltd., 18, Connaught St., Marble Arch, London, W.2. Paddington 2745. [3678

NEW RECEIVERS AND AMPLIFIERS

AIR KING,

THE Royalty of Radio.

ALL Models Feature Beam Tuning, Magic Eye Indicator, gramo. pick-up connections, and special output valves.

ALL Sets Fully Guaranteed; H.P. terms available from 3/- per week; our technical department is at your service.

WHOLESALE and Trade Enquiries Invited; generous terms.

ARCTURUS Valves for Improved Radio Reception on All Types of Receivers.

WRITE for Lists on These Famous Valves; prices from 4/9 each.

AIR KING RADIO, 115, Shaftesbury Av., Cambridge Circus, W.C.2 (1st floor above Barclay's Bank). 'Phone: Temple Bar 4875 (all lines). All receivers assembled in England. [3406

ALERT RADIO Co.

ALL-WAVE Receivers at £7/7, £9/9, and £13/13, A.C. or A.C./D.C.; Midget and other receivers up to 23 valves; for DX work we can supply the latest communication models.—21, East Rd., N.1. Clerkenwell 4871. [3220

ROYAL RADIO Co.

ESTABLISHED 1908.

ALL-WAVE Receivers, suitable for use on ships, as supplied to officers of many shipping lines.

OUR 8 and 10 Metal Valve All-wave Receivers; 15-2,000 metres, acknowledged by the trade as the best for range, tone, and generous performance.

LATEST 6-valve Car Radio, A.V.C., remote control, no suppressors required.

A FULL Range of the World Famous Fergusson and Pilot Models Stocked.

ALL Sets Fully Guaranteed by Ourselves.

ALL Types of American Valves Stocked.

ANY Make of Set Serviced by Our Qualified Radio Engineers at Reasonable Charges.

PAY Us a Visit Any Time, or send for full range catalogue; 1½d. stamp will be appreciated.

ROYAL RADIO Co., 5, Buckingham Rd., South Woodford, London, E.18. 'Phone: Buckhurst 2736. [3499

"SERVICE With a Smile."

HENRY FORD RADIO, Ltd.,

ELECTRONIC House, 22, Howland St., Tottenham Court Rd., W.1. Museum 5675. [0511

G5TS Presents the "Hallicrafter."

EVERY Instrument Perfectly Adjusted and Tested on the Air Personally.

"SKYBUDDY," complete with valves, speaker, etc.; £9.

"ULTRA-SKYRIDER," with crystal gate valves, etc.; £34.

"SKYCHIEF Super-Skyrider and Commercial," available 14 days.

BLUE-PRINT, full operating data, with all receivers; carriage free anywhere in British Isles. Terms, cash with order or c.o.d.

T. BRIAN SMITH, 115, Novar Drive, Hyndland, Glasgow. [3753

McCARTHY RADIO Special Offer.

McCARTHY RADIO have for Disposal a Number of Chassis at Attractive Prices; these are demonstration models, and therefore slightly soiled, though otherwise in new condition; fitted brand new B.V.A. valves throughout.

OFFERED as Complete Receivers, in brand new cabinets, with moving coil speakers, the following types:—

£6 6 !! (Complete in Cabinet, with speaker, as above).—6-valve Band-Pass Superheterodyne, with 3-watt pentode output; illuminated dial, principal station names; medium and long wave-bands, D.A.V.C., volume control, tone control (both operative on gram.).

£6/10 !! (Complete in Cabinet, with speaker, as above).—6-valve all-wave superheterodyne, covering 3 wave-bands (17-2,000 metres); illuminated "Airplane" dial, D.A.V.C., "Squelch" circuit, with muting control; provision on switch connects pick-up terminals; 3-watt pentode output.

£7 !! (Complete in Cabinet, with speaker, as above).—6-valve all-wave superheterodyne, specification as above, but with tone control and 6-watt push-pull output.

£8/10 !! (Complete in Cabinet, with speaker, as above).—8-valve all-wave receiver, with 6-watt triode push-pull output, R/F stage, 4 wave-bands (16.5-2,000 metres), illuminated "Airplane" dial, tone control, volume control (both operative on gram.), etc., etc.

LIMITED Quantity Only of these Bargain Receivers Available.

McCARTHY RADIO, Ltd., 44a, Westbourne Grove, London, W.2. Telephone: Bayswater 3201. [3754

ENQUIRE About Harmaur Radio 1937 Receivers.

AMERICAN-BOSCH "CentrOmatic" All-wave Sets.

FREED-EISEMANN Receivers as Bought by the B.B.C. and "The Wireless World."

PIERCE AIRO AC/DC All-wave and Car Radios.

RAYTHEON Valves. Trade enquiries.

THE HARMAUR RADIO Co., Ltd., 8, Clifford St., New Bond St., London, W.1. [0499

COULPHONE RADIO MANUFACTURING COMPANY, manufacturers of high class radio since 1923.

STANDARD Range A.C. All-wave Super Hets., delayed A.V.C., Rola speakers, British Tungsram valves, high class cabinets 12 months' guarantee (including valves); 4-valve 3½-watt, £6/10; 6-valve, £10; super 6-valve, R.F. stage, £15; super 8-valve, R.F. stage, 4 wavebands, 8-watt reversed phase push-pull, Rola G.12, £20.—Liverpool Rd., Hutton, Nr. Preston, Lancs. 'Phone: Longton 196. [3641

No. 24

Notes on Half-wave Aerials, Feeders, and the Suppression of Electrical Interference

In our endeavour to be accurate we have been trying to find the difference, if any, between a "di-pole" and a "doublet" aerial. We find that neither is the correct description of a vertical or horizontal aerial whether rigid or not. So, until the nomenclature is defined, we propose to refer to a half-wave aerial as such, and to describe it as centre fed or otherwise.

H.F. Low Impedance Transmission Line.

In "Notes" No. 15 (*Wireless World*, 4/12/36), we described a new feeder designed for conveying H.F. currents to or from a centre fed half-wave aerial. The breaking load of this cable (No. 319) was 20 lbs. Since this announcement we have had to design a heavier cable, weight per 100 ft. 2 lbs., with breaking load 80 lbs., and to the following specification:

Characteristic impedance in ohms—

at 45 m.c. = 80

,, 6 m.c. = 84

Loss in dB. per 100 ft.—

at 45 m.c. = 1.1

,, 14 m.c. = 0.6

Catalogue No. 336: Price 6d. per yard.

For the convenient connection of feeders to half-wave aerials we have found it necessary to produce a "T" strain insulator in porcelain and with sensible terminals. This is a great advance on anything else obtainable at present. List No. 333: Price 1/6.

If you have any knotty problems on interference send them up. We may publish suitable questions on this column, together with our suggestions. We are particularly anxious to hear of cases where suppressors give disappointing results under apparently ideal conditions. It is all for the common good. Do it now.

Send 1/2 for book "Interference Suppression," or for free copy of "'Eliminoise' Anti-Interference Aerial System" (all wave).

Constructors and designers will appreciate our book "Radio and Electrical Accessories," containing 150 illustrations, including 75 blue prints of curves, diagrams, circuits and constructional details, and specification of all our standard products in the accessory class. Send 8d. for copy, post free.

BELLING-LEE
SUPPRESSION SERVICE

Belling & Lee Ltd.
Cambridge Arterial Road,
Enfield, Middx.

Telephone: Enfield 3322.

NEW RECEIVERS AND AMPLIFIERS

ANGLO AMERICAN RADIO Offer the Finest Range of Chassis and Receivers at London's Lowest Prices.

50/-.—Exceptional bargain; Multi-band (7-2,000 metres) Communications outfit, battery, valves, 8in. speaker, metal cabinet, 7in. dial, with S.W. station names, band-spread together with 8in. world rotating globe on stand.

70/-.—A.C./D.C. 4 Communications outfit, var. mu., H.F., Pen. det., output Pen. rectifier, 100-250v. specification, otherwise as above.

67/6.—All-wave battery chassis, S.G. H.F. Pen-det.-Pentode, 16-2,000 metres, 3 bands, latest all-wave slow motion dial calibrated in metres, P.U. and extra speaker sockets, an excellent home receiver; supplied direct from prominent British manufacturer, 8in. moving coil speaker, 10/6; horizontal type cabinet, 12/6.

£5/19/6.—7-valve all-wave chassis, 3 bands, 16½-2,000 metres coloured tuning dial calibrated, visual cathode tuning, full A.V.C., A.C./D.C., 110-240v., exceptional performance; matched speaker, 10/6; cabinet, 12/6.

£7/19/6.—8-valve all-wave chassis, 16-2,100 metres, new De Luxe 5½in. airplane multi-indication dial A.V.C., tone control, calibrated all bands, 110-240v. A.C./D.C.; matched speaker, 12/6; cabinet, 14/6.

£8/19/6.—8-valve all-wave chassis, 16-2,100 metres, visual cathode tuning, 7½in. super airplane multi-indication dial, 4 watts output, A.V.C., tone control, A.C. operation, 110-240v.; matched speaker, 12/6; horizontal type cabinet, 15/6.

£5/19/6.—Car Radio 5-valve superhet, highly efficient, A.V.C., tone control, illuminated dial, magnificent performance, complete with suppressors and sundries and complete operating and fixing instructions; demonstrations under London traffic conditions daily.

CABINETS Offered With Chassis are of Finest Quality and Finish, and as supplied by manufacturers with chassis; where cabinets are ordered with chassis these are despatched fitted as complete receivers.

3D. Stamp Brings Complete Lists Receivers, short-wave components, covering every radio need; London's lowest prices throughout; terms: cash with order or on delivery.

ANGLO AMERICAN RADIO (AND MOTORS), Ltd., (Dept. W.2), Albion House, New Oxford St., London, W.C.1. (Telephone: Temple Bar 3231.) [3761

ARMSTRONG COMPANY Manufacture 8 Radio Receivers in Chassis Form, briefly described hereunder.

ARMSTRONG 6-valve All-wave Superheterodyne Radiogram Chassis, for A.C. mains, complete with Rola speaker; £7/10.

ARMSTRONG 8-valve 4 Wave-band Radiogram Chassis, with phase reversed push-pull output; £9/17/6.

ARMSTRONG 6-valve 4 Wave-band Radiogram Chassis, with large triode output; £8/17/6.

ARMSTRONG 8-valve 4 Wave-band Radiogram Chassis, with radio-frequency stage and push-pull output; £11/11.

ARMSTRONG 7-valve 4 Wave-band Radiogram Chassis, with radio-frequency stage and single triode output; £10/10.

ARMSTRONG 8-valve 2 Wave-band Radiogram Chassis, with 8 watt push-pull output; £8/10.

ARMSTRONG 6-valve 2 Wave-band Radiogram Chassis, with single large triode output; £7/10.

ARMSTRONG Chassis Carry 12 Months' Guarantee.

ARMSTRONG Chassis are Sent 7 Days' Trial, carriage, packing, and crate free.

ARMSTRONG MANUFACTURING Co., 100, King's Rd., Camden Town, N.W.1. [3460

11-VALVE American Receivers, four wavebands, bargain prices; stamp for particulars.—Bennett, 4, Humberstone Drive, Leicester. [3729

1937 Radios; save money by dealing with the actual importers; send 1½d. stamp for catalogues.—American Radio Distributing Co., 7, Grove Rd., Folkestone. [3756

CHASSIS, Peerless latest American 9-valve, 3-wave, 8in. speaker, £9/15; ditto, 11-valve 5-wave, 12½ speaker, 18 watts, 1938 model £14/14.—Kay, 1, Old Church Lane, N.W.9. [0547

TRANS-ATLANTIC RADIO Co., 15, Percy St., W.1. Museum 3096.—Splendid range latest American A.C./D.C.; compacts from 59/6; all-wave consoles, etc. "Philco's" stocked. [3745

"SKYBUDDY," by Hallicrafter, 5-valve superhet., in all-metal cabinet, band spread tuning, built-in speaker, B.F.O. pitch control, 'phone jack, A.V.C. switch, all newest innovations, a real hand job; £9.

£13/13.—8-valve 4 band all-wave superhet., 12½-2,050 meters, 8 watts, undistorted output, world-wide reception, marvellous quantity, magnificent walnut Consolette.

SETS Guaranteed 12 Months, valves 6 months, with Radiographic satisfaction, or money refunded guarantee.

CARRIAGE Free; send cash with c.o.d. or order.

RADIOGRAPHIC, Ltd., 66, Osborne St., Glasgow. C.1. [3751

PILOT, Ferguson, Pegasus and Air King all-wavers lead the field; our deliveries are prompt in original cartons with full guarantees; your trade card will bring our wholesale catalogue from the authorised distributors.—Leonard Heys, 36, Henry St., Blackpool. [0530

YOU Want Something Completely Different. If you have a nicely furnished home and the stereotyped models you see on every street corner do not appeal to you, you will delight in our superb range of exclusive quality models. We have radiograms with and without auto record changers, A.C. and A.C./D.C., which are a complete breakaway from the usual stuff in the local shops. If you prefer good furniture to boxes, if you want outstanding shortwave performance, and above all if you appreciate true quality of reproduction when you hear it, we have what you are looking for. Come and see. Come and listen. You will be agreeably surprised, not only to find that such splendid models exist, but that they can be sold at such very reasonable prices.

WIRELESS SUPPLIES UNLIMITED, 278-280-282, High St., Stratford, E.15. Maryland 3191. [3550

FUN IN IDEALISM

We wonder how many people noticed the quite excusable misprint which occurred in our last advertisement wherein it was stated that the 036 Transformer fitted to our "S.S. Super Auditorium Speaker" has a straight Line characteristic from 20 to 10,000 cycles.

Now this standard is recognised by most people to be absolutely first grade, but we get no end of fun, trying to produce something better, and our advertisement should have read *"within .5 D.B. from 20 to 20,000 cycles."*

Again in the matter of Amplifiers, 3 D.B. down at 50 cycles and 2 D.B. at 10,000 cycles would be considered quite a good Amplifier, but the S.S. 346 model, which gives an output of 4-6 watts and costs only £10, is within 1.5 D.B. from 20 to 10,000 cycles, it has been measured up to 20,000 which shows a 3 D.B. overall loss including output transformer, at that figure. Even our small Mains Transformers are flash tested at 3,000v. A.C. and have an efficiency of over 80 per cent.

NO WONDER WE ARE BUSY!

May we send you further particulars ?

SOUND SALES

MARLBOROUGH RD. UPPER HOLLOWAY, LONDON, N.19.

LIMITED.

(Contractors to the G.P.O., etc.)

Tel.: Archway 1661/2/3.

RICH & BUNDY

Heavy Duty Components

for

PUBLIC ADDRESS AMPLIFIERS, MAINS TRANSFORMERS and CHOKES.

Loaded Intervalve Transformers.

OUTPUT TRANSFORMERS

Specially designed and manufactured for all High Efficiency "LOW LOAD" and CLASS "A—B" AMPLIFIERS.

Send your enquiry to :—

RICH & BUNDY LTD.

Transformer Manufacturers,

NEW ROAD, PONDERS END, MIDDLESEX.

Telephone : Enfield 0777.

CABINETS

We specialise in manufacturing to specification Hand-made and acoustically designed throughout. 1½d. stamp for details of standard models.

THE LOCKWOOD CASEWORK MNFG. CO.,
rear of 65, Lowlands Road, Harrow, Mdx.

BYRON 1818.

THE MOTOR CYCLE Every Thursday 3d. W.W.15

RECEIVERS AND AMPLIFIERS
CLEARANCE, SURPLUS, ETC.

HENRY'S.

SHORT-WAVE Units by Well-known Manufacturer, 13-70 metres, supplied in handsome walnut cabinet, complete with coils, adaptors and instructions, no alterations to your present set, one plug connection, for all A.C. mains or battery sets, listed at £3/3; our price 30/-, carr. pd., in sealed cartons.

HENRY'S, 72, Wellington Ave., London, N.15. Stamford Hill 2907. [3759

CLEARANCE List (Trade Only).—Write Leonard Heys, 36, Henry St., Blackpool. [0527

A BARGAIN List of New Sets from 75/-.—Write Kay, 1, Old Church Lane, N.W.9. [0535

12 WATT Amplifier, complete, £7; 5 watt amplifier, complete, £4/10; superhet tuning unit for above, complete, £4; Garrard A.C. record changer unit, £5.—91 Flat, Mantell St., N.1. [3766

BATTERY CHARGING PLANT

CARFAX "Junior," 20/30v., 5a., £5/5; guaranteed five years.—British Rectifiers, Vernon Place, Cheltenham. [3573

PUBLIC ADDRESS EQUIPMENT

SPECIAL Offer!!!

8½ Guineas Assembled: Vortexion 20 watt 4-stage P.A. amplifier, in steel case, 8in.×10in.×9in. high, with carrying handle, input with controls for microphone and pick-up and tone control, output for 7½ and 15 ohm speakers, weight 25lb.; only 8½ guineas, with valves.

4 Input Model, with mixers; £10.

HEAVY Duty Model, as fitted to cinemas and dance halls; £15.

CALL and Hear the Rumble of an Organ as Never Before on our Wide Frequency Range Models, the best yet.

VORTEXION, Ltd., 182, The Broadway, Wimbledon, S.W.19. See also New Mains Equipment. [3439

WESTERN Electric 555w. Receiver, new; £7/10.—Williams, 11, Wellington Rd., Bexley, Kent. [3742

PARTRIDGE P.A. Manual, free to trade. See "Partridge Transformers" under "New Mains Equipment." [3487

BROWN'S 30-watt Amplifier, two cone speakers, engine, etc., complete; what offers?—B. Moffat, Egremont, Cumberland. [3707

IGRANIC Transverse Microphone, cost £17, perfect, £4; floor stand for same, 15/-.—Williams, 11, Wellington Rd., Bexley, Kent. [3740

HARMONY HOUSE SOUND SERVICE, Southport.—Beam power amplifiers, 14 watts output; £13/10 (subject); send for lists. [0546

FOLDED Exponential Horn 96 Air Column With 555w. Receiver, Western Electric make; £11.—Williams, 11, Wellington Rd., Bexley, Kent. [3744

WESTERN Electric Differential Microphone With Mounting, as new, cost £32; accept 75/-.—Williams, 11, Wellington Rd., Bexley, Kent. [3741

7½ ft. Exponential Straight Horn With 555w. Receiver, both by Western Electric, range ½ mile; as new; £12.—Williams, 11 Wellington Rd., Bexley, Kent. [3743

THE Coronation and After Will Demand High Quality P.A. such as Our Crystal Mike, flat response high gain 15 watt Udo amplifier and 10 watt P.A. speakers; cat. free.—Holiday and Hemmerdinger, P.A. Specialists, Holmer Works, Dolefield, Manchester, 3. [3747

VAN and P.A. Equipment, all accessories and spares, range ½ mile or audience 25,000, high quality reproduction, suit dealer, photos, details installations made may be inspected, will earn price asked at Coronation engagements, reason sale and all particulars by appointment; £80, or nearest offer.—Williams 11, Wellington Rd., Bexley, Kent. [3739

USED SETS FOR SALE AND WANTED

DYNATRON

DYNATRON 1936 6v. A.C. High-fidelity Chassis, var-selectivity, 2v. S.W. chassis coupled to same, large Rola, perfect performance; £12/12.—"St. Clare," Altwood Bailey, Maidenhead. [3719

EKCO

1937 Ekco Radiogram, list price £23 2s., unused wedding present, owner moving to D.C. district; will accept £17/10.—Slater, 4, St. Dunstan's Rd., W.6. Riv. 2985. [3692

McMICHAEL

McMICHAEL 363 Transportable Battery Superhet; delivered 21st Dec., maker's guarantee.—Offers to Box 681, c/o *The Wireless World*. [3715

McMICHAEL'S Colonial Model Short-wave receiver (superhet), £5/10; "M.L." anode converter, £3.—Lobley 11, New Park Rd, Chichester. [3725

McMICHAEL £17/17 Model S.M.C. Duplex Suitcase Portable, complete khaki twill carrying case, condition as new.—Offers to Box 680, c/o *The Wireless World*. [3714

MONODIAL

PROFESSIONALLY Built Monodial, to specification, in perfect order, £9; amplifier pack (pentode), £5, with valves.—Twentieth Century, George St., Sutton. [3731

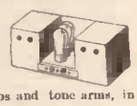
R.G.D.

R.G.D. 625 All-wave Table Receiver, demonstration use only, guaranteed perfect; 19 guineas.—Elliotts, 89, Talbot Rd, Bayswater 1071. [3712

ELECTRADIX

PUBLIC ADDRESS BARGAINS

AMPLIFIERS. We can supply from stock 3, 6 or 10 watt Mains or Battery Amplifiers in portable or chassis form at lowest prices. Special Public Address or Dance Band Portable with mike and speaker, £12. Phillips 2 watt 110/230v. small A.C. Mains Amplifier, £4/10/-. 10 watt A.C. Mains Amplifier, 200/250v., new, with valves, steel case, £10. Fine new 6 watt 3 stage A.C. Amplifier and mike, 1936/7 G.E.C., complete with 4 valves. List 26 gns., unused. Sale £14. Almost new Ardente 20 watt Amplifier. Sale £24.



10 Watt Portable Recording Gramo type ditto, with turntable, pick-up and mike, £15. A.C./D.C. Double Turntable set for Entertainment or Recording, 2 universal motors, turntables, pick-ups and tone arms, in portable steel cabinet, 40-guinea set, £18.

SPEAKERS. P.A. with Big Horns.

M.C. Horn Unit, large type, new, 8 ohms, 8/10 watts, £5/10/-; Trix Horn, small, new, 8 ohms, 5 watts, £6; Trix Horn, large size, new, 8 ohms, 8/10 watts, £7/10/-; Brown's Horn, large size, with transformers, for 7,000 ohms load, 5/7 watts, 50/-; M.C. Vitavox 6 volt Units, 8 ohms, 15 watt size, 30/-; Brown's 36in. horn, diaphragm unit, 120 ohm impedance, 70/-; Short Horn Tannoy 12v. car, 11-guinea Speaker, 8 watts, £7/10/-; Brown's Cabinet P.A., 5/7 watts, with transformer, £4; Siemens Giant Riffell P.A. Speakers, 25/-.

Prism, with Tone Correct Horn and Slings, Perm. Mag. M.C., 15 watts, 24in. Flare, 40in. long, £8/3/-.

Various High Power P.M. Speakers on baffles and in cabinet, cheap.

7/6

MAINS ENERGISED SPEAKERS.—6in. R. & A., 2,500 ohms, with speech transformer, 7/6. Magnavox, 6in. type, "144," 2,500 ohms, 12/6. A.C. MAINS SPEAKERS, WITH RECTIFIERS, Jensen, 220 volt, 7in. cone and transformer, 25/-; 100 volt, ditto, 7in. cone, 20/-; 100 volt A.C., 8in. cone with transformer, 21/-. BATTERY ENERGISED SPEAKERS.—K.B., 6 volt, 8in. cone, 8/6; New Sonochorde, P.M., "Class B," fitted transformer, 20/-.

R.M. CABINET SPEAKERS.—Hegra P.M., in oak cabinet, 12in.×12in.×12in., 25/-. H.M.V., P.M., heavy duty, 5 watt with transformer, 50/-; H.M.V., A.C. energised, 200/250 volts, 5 watts, with transformer, 65/-. Siemens Magnet table speaker, 4/-.

MICROPHONES. We are makers and carry the largest and most varied stock in London. Prices are low and there are models for all purposes Microphones, Hand and Stand.—Transverse, Crystal, Condenser and Mov.-Coil. Our Public Address Eisel-Reiss Transverse Current Microphones are far Superior and all the best judges use them.

Only 55/- *High-grade Stand, as illustrated* 15/- *extra*

55/-

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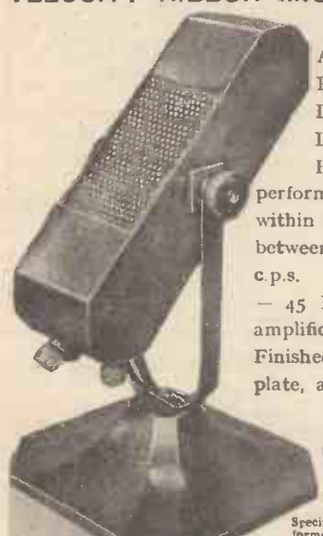

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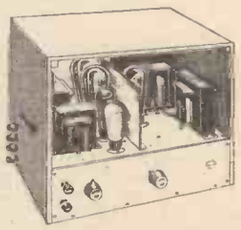

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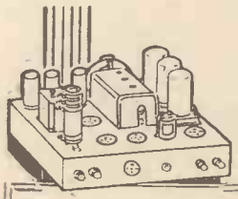

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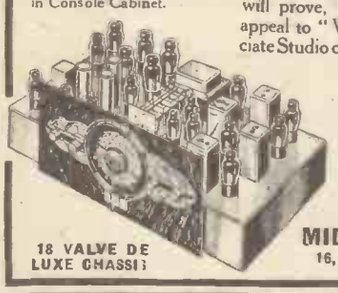

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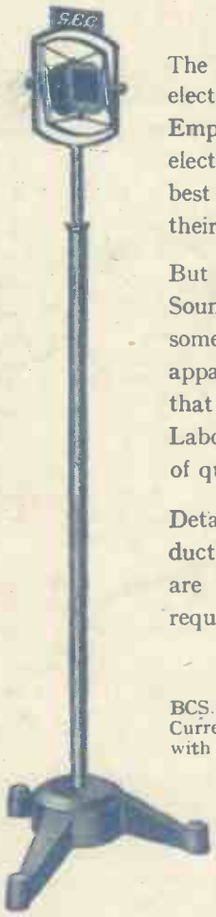

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STUDIO ACOUSTICS—A New Technique

The Wireless World

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THE PRACTICAL RADIO & TELEVISION JOURNAL

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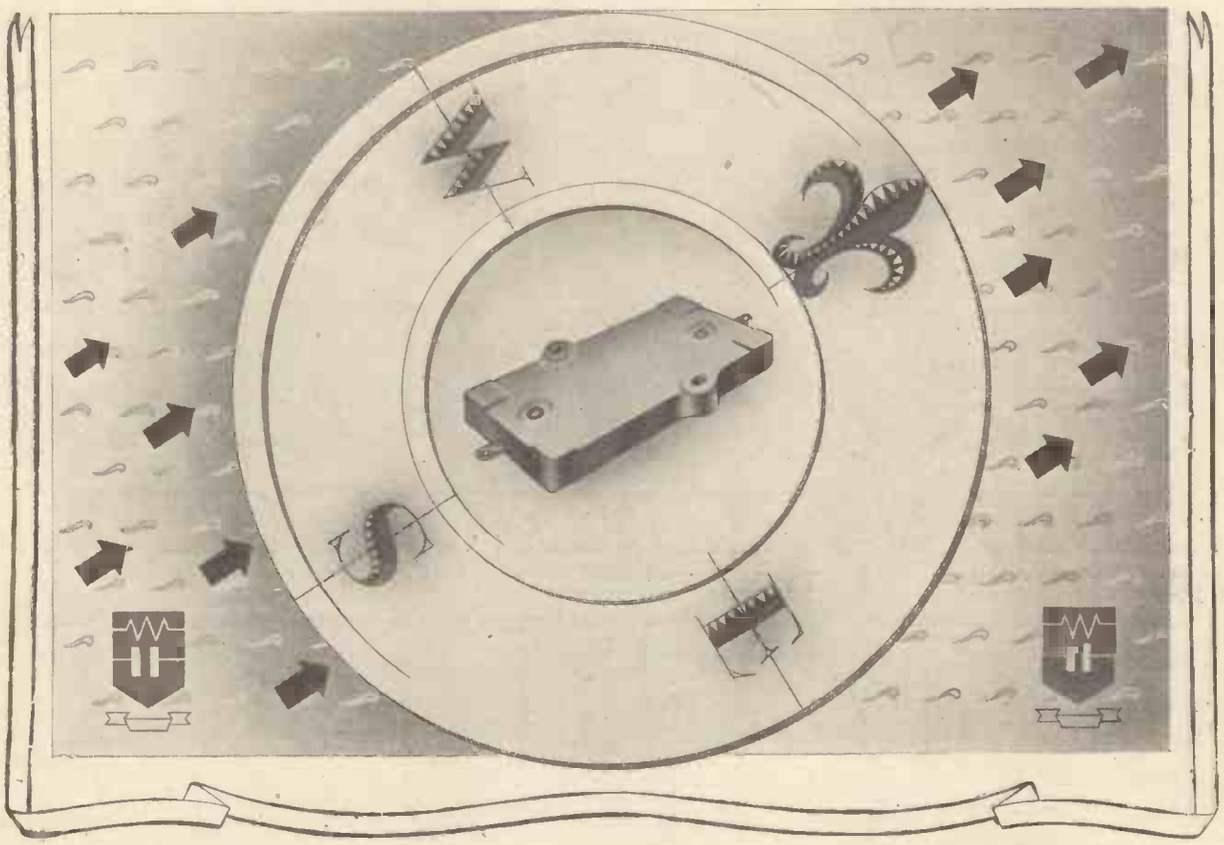

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As many of the circuits and apparatus described in these pages are covered by patents, readers are advised, before making use of them, to satisfy themselves that they would not be infringing patents.

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EDITORIAL COMMENT

Plug-in Listening

An Important Judgment

THE tenant of a flat who plugs his loud speaker into points wired up to a central receiver stands on exactly the same footing as any other listener, so far as the P.M.G. licence is concerned. Although, in a sense, he shares his reception with other tenants, he cannot share the cost of the yearly licence with them. Every tenant who uses the wiring to receive the broadcast programmes must take out his own individual licence and pay 10s. a year for it.

This is the effect of a recent High Court judgment which overrules a decision to the contrary given some weeks ago by the Magistrate of the Marylebone Police Court.

The Magistrate was influenced by the wording of the Wireless Telegraphy Act, which compels a person to take out a licence if he "instals or works" a wireless receiver. He held that the mere plugging-in of a loud speaker to an existing pair of wires did not cover either the "installation" or the "working" of a set within the meaning of the Act. In his opinion, the loud speaker merely repeated signals, which were in fact produced or tuned-in from the ether at some other point. The apparatus which captured the signal should of course, be licensed, but not every loud speaker that happened to be plugged-in to terminals along a common line.

However, Lord Hewart, Mr. Justice Smith and Mr. Justice Goddard, sitting in the King's Bench Division of the High Court, all thought otherwise when the case was brought before them on appeal.

Lord Hewart, in delivering judment, said that the Magistrate's view was too narrow. Although the tenant did not actually "tune" any wireless apparatus, he undoubtedly made use of a wire which formed an integral part of that apparatus. The function of the wire was to allow the tenant to enjoy the broadcast service, and in that sense it was certainly a very important part of the wireless apparatus. It was not right, in his (Lord Hewart's) opinion to say that the only "working" of a wireless set lay in the tuning of it.

The original action was fought as a test case, and the result, as stated above, will affect a large number of plug-in listeners all over the country.

Interaction of Radio Waves

Will Readers Please Assist ?

IN the correspondence columns of this issue we publish a letter from Professor V. A. Bailey, of Sydney University, and we would like our readers to take special note of the request he makes for observations affecting the theory of interaction of radio waves.

Professor Bailey is in England for only a few weeks, and we hope that our readers will be ready to give him all the co-operation possible in his investigations. The form appearing elsewhere in the issue will enable readers to enter their observations in a way which will facilitate his use of the data provided.

It should be particularly noted that the type of interaction referred to is that occurring when signals from stations other than those occupying adjacent channels are heard as a background to the programme from the "wanted" station to which the set is tuned.

Report forms should be sent to Professor Bailey, c/o *The Wireless World*.

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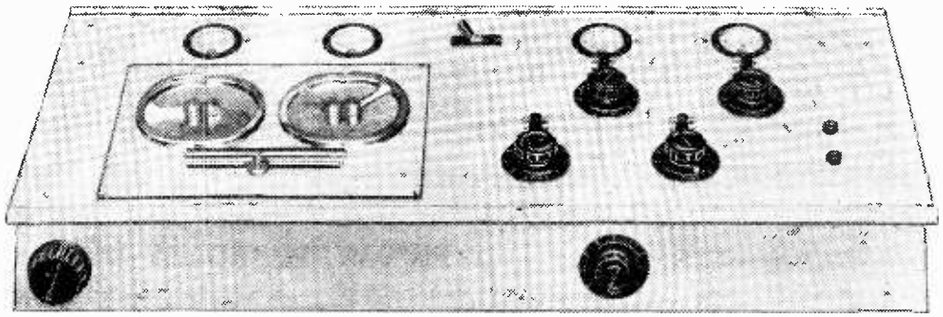
Reverberation Control

STUDIO CHARACTERISTICS "TO ORDER" BY ELECTRICAL MEANS

By E. AISBERG
(Editor, "Toute la Radio")



Reverberation control panel installed at Poste Parisien.

BY the time this article is in print, the Poste Parisien is expected to have put into operation a new electrical system for picking up sound. We have heard gramophone recordings of effects obtained with the help of the system, and were greatly impressed by its possibilities for improving musical reproduction and in simplifying studio acoustics. A new technique of dramatic control is also introduced and it is claimed that, once again, Science offers to Art a new means of expression.

WHEN a year or two ago I had the pleasure of visiting Broadcasting House, that miracle of comfort and good taste, I was very much impressed with the multiplicity of studios which the beautiful building at Portland Place contains. More recently, when browsing over the plans for the future Funkhaus in Vienna, which I saw at the Ravag headquarters, the same thing struck me.

Is so much space and so much money sacrificed solely to create the appropriate atmosphere for each type of transmission? Certainly not. The reasons for this elaboration are connected with the problem of acoustics of buildings in its particular application to picking up sound.

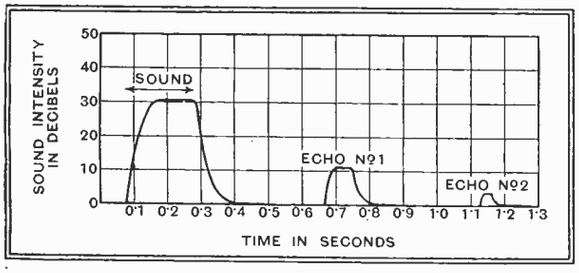


Fig. 1.—Echoes are separated from the initial sound, but . . .

Each hall, each studio, has what musicians describe as a particular "colour." The same sound, depending upon whether it is produced in a small room with the walls covered with drapery, or under the arches of a cathedral, will have quite a different "colour." This "colour" acoustic engineers have been familiar with for a long time; it depends upon the reverberation of the sound, that is to say, on the extent to which its duration is prolonged by multiple deflections from walls and different objects in the room. One should not, however, confuse reverberation with echo, the latter being a repetition of the sound at regular intervals, and is, from the musical point of view, a most undesirable phenomenon (Figs. 1 and 2). Reverberation, on the contrary, is an indispensable element of music which provides it with that charm and richness which acoustic engineers strive to obtain through the dimensions and arrangement of concert halls, etc.

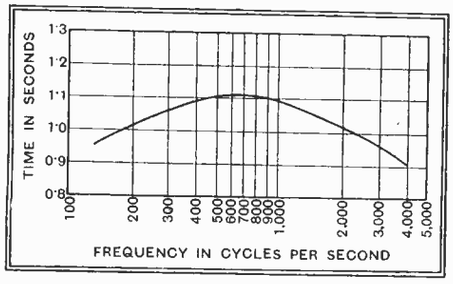


Fig. 3.—Reverberation curve of the military band studio, No. 8A, in Broadcasting House, London.

The reverberation period (that is to say, the interval of time between the end of a transmission of sound at the source and the complete extinction of the sound wave in the hall or studio) depends upon a number of factors; the shape of the room, the capacity of walls and furnishings to absorb the sound to a greater or lesser extent (everyone has noticed the difference of sound in empty halls and when such halls are filled with an audience), the relative disposition of the sources of sound, etc. It depends also (and this is a very important point) on the pitch of the sound.

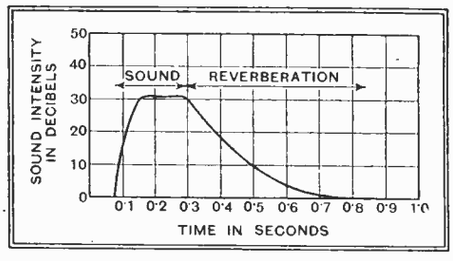


Fig. 2.—. . . reverberation causes the sound to persist after the end of the impulse from the source.

Reverberation Characteristics

In checking the duration of reverberation for different frequencies, it is possible to trace the curve of reverberation of a room, and this really constitutes its sound characteristic. To give an example, Figs. 3 and 4 represent the characteristic curves of two B.B.C. studios.

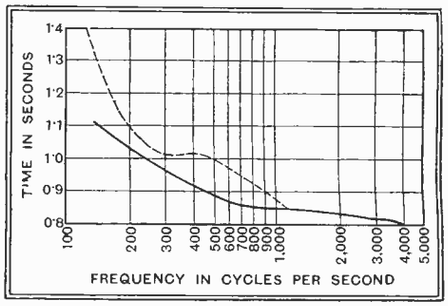


Fig. 4.—Reverberation curve of a medium-size studio at Broadcasting House.

In making a comparative study of the reverberation curves of different rooms, Knudsen has endeavoured to establish ideal curves which would assure the best distribution of speech and music (see Figs. 5 and 6). However, in practice it is not possible to get satisfaction from one studio for all types of music and whatever may be the source of music which is being picked up. This is why for recording sound for cinema films it is preferable to reduce the reverberation to a minimum, because the reverberation of the cinema halls where the projection will take place is sufficient. In the same way, in broadcasting, when it is a question of a piece of music comprising rapid passages, a highly damped studio is indispensable in order to prevent the mix-up of sound waves and the distortion which would result. But, on the other hand, it is seldom that a piece

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Reverberation Control—

of music retains the same speed for any length of time. More frequently we get the condition of an alternation between rapid and slow passages. In a very highly damped studio the rapid passages retain their crispness, but at the expense of slow passages, which will sound flat or lifeless. However, if the slow passages retain all their brilliance in a studio which has sufficient reverberation, then the rapid passages are distorted.

Formerly, sacrificing everything to clarity, very highly damped studios were built. But listeners insisted on their preference for the more brilliant music which could be obtained where reverberation was present in the studios. At present, studios are being constructed which have greater resonance, and when space and financial means permit studios are designed with different reverberation curves, suitable for different special uses, as in the case of Broadcasting House (which even has a studio where reverberation is practically

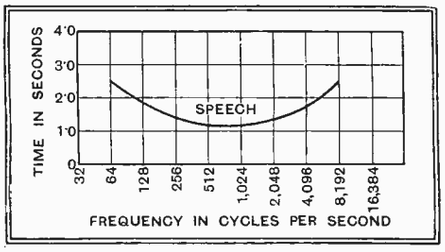

Fig. 5.—Reverberation curve giving best results for speech (after Knudsen).

absent, so that sounds do not carry and one gets the impression of being in a tomb).

Controllable Reverberation

Of course, the ideal solution might consist of providing means for varying the reverberation curve of a single studio to suit the character of the broadcast, and even to change conditions during the performance of one item. This idea has been realised in one studio at Hamburg, where an arrangement of movable walls and drapings, silently operated, enables the reverberation curve to be infinitely varied.

But when we are concerned with a force so flexible as electricity, why should reverberation characteristics depend upon mechanical solutions which are more or less clumsy? This was the idea which came to Monsieur Bernhardt Roux, who is a distinguished pioneer of phonographic recording, and his assistants, MM. Gamzon and Sollima, who, with the help of advice from a talented musician, Monsieur Eric

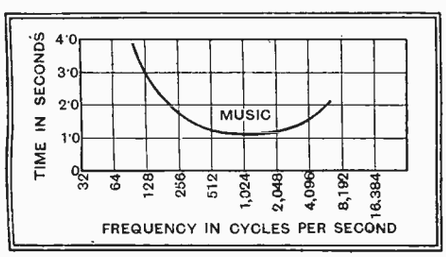

Fig. 6.—Best reverberation curve for music (Knudsen).

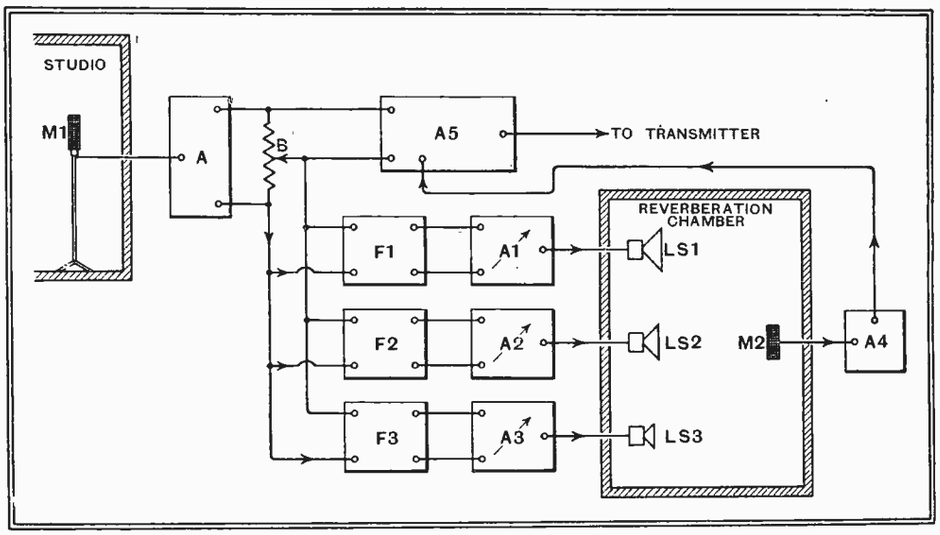

Fig. 7. General arrangement of the adjustable reverberation system of Roux-Gamzon-Sollima-Sarnette.

Sarnette, whose work is widely recognised in the field of electrical reproduction, developed an ingenious system for providing variable electrical reverberation. The simple nature of the basic idea is indicated by the circuit of Fig. 7.

The studio which is employed is heavily damped. The current from the microphone, after pre-amplification in the amplifier A, is separated into two channels, the relationship of which can be regulated with the aid of potentiometer B. The one channel following the normal route is taken to the modulation amplifier A5, whence it is taken to modulate the transmitter. But the other part of the output from A is, in turn, separated into three channels, divided up according to frequency. This operation is carried out by means of band filters F1, F2 and F3, which are respectively low-, medium- and high-note filters. These filters are separately adjustable so that the band of frequencies fed from each of them can be broadened or narrowed at will.

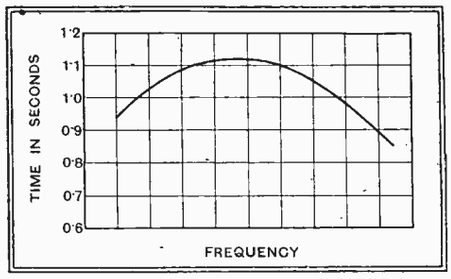

Fig. 8.—Studio reverberation curve.

Thus divided, the three output currents are amplified by means of amplifiers A1, A2 and A3, with provision for varying their outputs, and they are then carried to the three loud speakers, LS1, 2 and 3, placed in a reverberation chamber. This chamber, which is practically a cube and of a capacity of about nine cubic metres (small enough to obviate echo), has smooth and bare walls of hard material. The period of vibration in this chamber can reach ten seconds. The sound is collected by the aid of a second microphone M2, the current from which, pre-amplified by the amplifier A4, is added to the

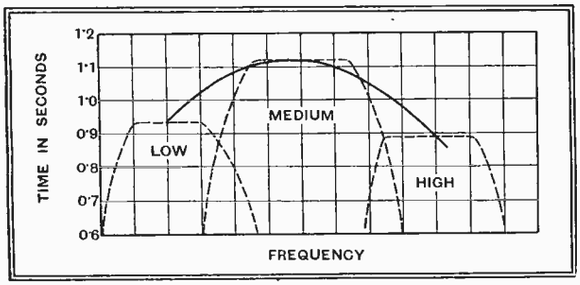

Fig. 9.—The same curve as that of Fig. 8, obtained by the appropriate adjustment of three electrical reverberation circuits.

"direct" current passing through A in the modulation amplifier A5.

Thus, depending upon the adjustment of the potentiometer B, we add to the current unaffected by reverberation a reverberation current more or less powerful. In itself, this idea is not new (take, for instance, the "echo corridor" of the B.B.C.), but what is outstanding is that in this new arrangement we have the ability to modify not only the general strength of reverberation but the relative intensity for different frequency bands. We can thus model the curve of reverberation according to our requirements, by regulating individually the strength of the low notes (A1), the medium (A2) and the

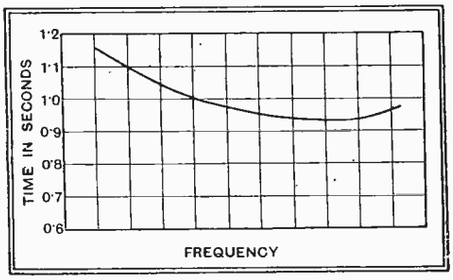

Fig. 10.—Another reverberation curve.

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Reverberation Control—

high notes (A3). The curves 9 and 11 indicate how, with this procedure, one can artificially create reverberation characteristics of studios as shown in the curves of Figs. 8 and 10.

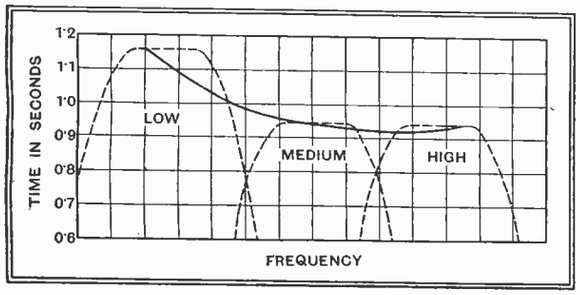
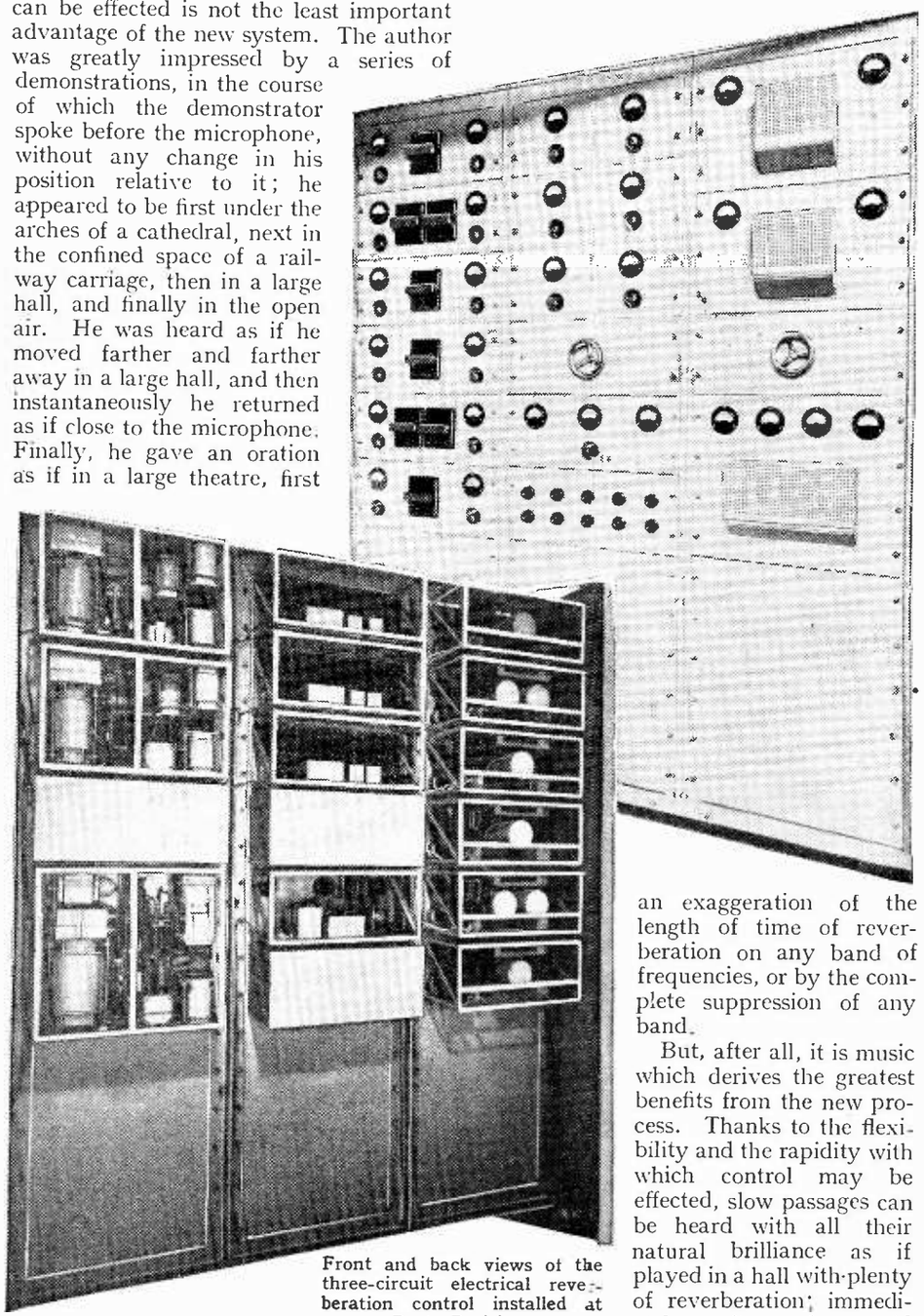


Fig. 11.—An electrical copy of the reverberation curve of Fig. 10.

The rapidity with which the changes can be effected is not the least important advantage of the new system. The author was greatly impressed by a series of demonstrations, in the course of which the demonstrator spoke before the microphone, without any change in his position relative to it; he appeared to be first under the arches of a cathedral, next in the confined space of a railway carriage, then in a large hall, and finally in the open air. He was heard as if he moved farther and farther away in a large hall, and then instantaneously he returned as if close to the microphone. Finally, he gave an oration as if in a large theatre, first of all as if it were empty, and then as if the audience had taken their seats. All these artificially obtained effects were carried out so well that, in spite of being acquainted with the procedure, the illusion was at all times perfect.

Here, then, is a method for obtaining in the broadcasting theatre those changes in acoustic effects which have hitherto been missing. Electrically controllable reverberation enables us to change progressively or instantaneously the apparent location of the source of sound, and to provide broadcasting with the equivalent of the "travelling" cinematograph camera. Sound effects previously unknown can be obtained by



Front and back views of the three-circuit electrical reverberation control installed at Poste Parisien.

an exaggeration of the length of time of reverberation on any band of frequencies, or by the complete suppression of any band.

But, after all, it is music which derives the greatest benefits from the new process. Thanks to the flexibility and the rapidity with which control may be effected, slow passages can be heard with all their natural brilliance as if played in a hall with plenty of reverberation; immediately afterwards rapid passages can be repeated as if they were being played in highly damped studios.

The Poste Parisien broadcasting station will be the first to employ this new development. It should be remembered that, in spite of the apparent simplicity of the scheme, long months of development have been necessary before it could be put into effect. In its present form it comprises a number of original details (as, for example, a system which maintains the sum of the output of the amplifiers A1, A2 and A3 constant in spite of variations in the strength of individual ones). It is believed that when the great advantages of the system have been appreciated it is likely to be adopted by all transmitters so as to improve quality and, incidentally, to avoid the necessity for constructing a variety of studios.

Television Programmes

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Vision	Sound
45 Mc/s.	41.5 Mc/s.

FRIDAY, FEBRUARY 12th.

3, Exhibits from the British Industries Fair which opens next week. **3.15,** British Movietonews. **3.25,** Friends from the Zoo; animals introduced by David Seth-Smith. **3.40,** Film. **3.50,** Cabaret.

9, Repetition of 3 programme. **9.15,** Gaumont British News. **9.25,** Repetition of 3.25 programme. **9.40,** Film. **9.50,** Cabaret.

SATURDAY, FEBRUARY 13th.

3, The Construction of a rockery demonstrated by C. H. Middleton. **3.15,** Gaumont British News. **3.25,** Variety.

9, Repetition of 3 programme. **9.15,** British Movietonews. **9.25,** Variety.

MONDAY, FEBRUARY 15th.

3, Major Faudel Phillips. **3.15,** Airports Exhibition. **3.25,** Gaumont British News. **3.35,** The B.B.C. Dance Orchestra.

9, Repetition of 3.15 programme. **9.15,** British Movietonews. **9.25,** Casino—A Dinner Time Floor Show.

TUESDAY, FEBRUARY 16th.

3, The Orchestra and its Instruments—IV: Philip Thornton demonstrates hybrid wind instruments. **3.20,** British Movietonews. **3.30,** Table Tennis: exhibition replay of the Men's finals of the English Open Championship as played at Wembley on February 11th–13th. **3.45,** Starlight—Gracie Fields.

9, Repetition of 3 programme. **9.20,** Gaumont British News. **9.30,** Table Tennis: exhibition replay of the Women's Finals of the English Open Championship as played at Wembley. **9.45,** Cabaret.

WEDNESDAY, FEBRUARY 17th.

3, Practical Dress Designing demonstrated on a living model. **3.10,** Music Makers: Eileen Joyce. **3.20,** Gaumont British News. **3.30,** Twenty-ninth Picture Page.

9, John Carr's Jacquard Puppets: Miniature Marionettes. **9.20,** British Movietonews. **9.30,** Thirtieth Picture Page.

THURSDAY, FEBRUARY 18th.

3, Parade of Fashions Displayed at the Textile Section of the B.I.F. White City. **3.15,** British Movietonews. **3.25,** First Aid—IV. **3.35,** Film. **3.45,** Shakespearean Scenes.

9, Mr. Hore-Belisha. **9.15,** Gaumont British News. **9.25,** Cook's Night Out—III: Marcel Boulestin's cooking demonstration. **9.40,** "A Policeman's Serenade": opera in one act by A. P. Herbert.

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The Television Receiver

I.—The Cathode-Ray Tube and Receiver Characteristics

By W. T. COCKING

IN the series of articles, of which this is the first, the design of television receivers will be considered in detail. The present article deals with the characteristics which the receiver must possess.

BEFORE it is possible to design a television receiver it is naturally necessary to know what kind of input the cathode-ray tube requires. The tube usually consists of an electron emitting cathode of the indirectly heated variety and a series of anodes. These are more properly termed accelerators, and the voltages applied increase with their distance from the cathode; they are usually cylindrical structures through which the electrons pass, and one of their most important properties is to focus the electrons into a beam. This beam, on striking the fluorescent screen at the end of the tube, produces a spot of light.

In television tubes the outermost anode is generally given a steady potential relative to the cathode of some 3,000-6,000 volts; the second anode needs about 800-1,200 volts; and the first anode something like 300-500 volts. The first and third anode voltages are usually fixed, but the second anode potential must be variable since the focusing of the spot on the screen is critically dependent on it.

After passing the accelerating electrodes the electron beam passes between two pairs of plates mounted at right angles. Potentials applied between one pair of plates enable the beam to be deflected horizontally, while voltages on the other pair move it vertically. The scanning voltages generated by the double-time-base[1] are applied to these plates, and enable the electron beam to be so moved that a raster is built up on the screen.

Around the cathode is a metal casing with a hole in it facing the accelerating electrodes, and electrons emitted from the cathode must necessarily pass through this hole before they can progress on their path to the screen. Whether or not they can do so, and if they can the quantity which are able to escape, depends on the potential of this electrode. By analogy with a valve, it is called the grid, in spite of its being anything but grid-like in appearance, and it is operated at a potential negative with respect to the cathode by 25-250 volts, depending on the design of the tube.

Varying the grid potential changes the number of electrons in the beam, and hence the brilliance of the spot of light. Modulation is thus effected by applying the vision signal to the grid. Just as in the case of the ordinary valve, there are definite limits to the permissible change in grid voltage. At one value of negative grid voltage the beam is so reduced that the light spot is extinguished, and this must obviously correspond to black in the picture. As the negative grid voltage is reduced—that is, changed in a positive direction—the raster gets brighter and brighter. At one particular voltage, however, defocusing occurs, and when the raster is closely examined the lines can be seen to merge into one another instead of being quite sharp and distinct. This point is the other limit in operation, and must correspond to white in the picture.

Black is naturally black in all tubes, and has the same light value, which is nothing. The brilliance of white at the point of defocusing, however, depends on the design of the tube, the material used for the fluorescent screen, and upon the applied voltages, in general increasing with the third anode voltage. The tube is being used to the full when the signal modulates the beam between the above defined limits of black and white.

The Vision Signal

The total grid voltage required to modulate the beam fully must be the vision signal output of the receiver. It is expressed as a peak-to-peak voltage (abbreviated p-p), and is equal to the change of DC grid voltage required to change the brilliancy by the same amount. This peak-to-peak voltage rating will be new to many and is adopted because the voltages in television are not so easily expressed in sine waves for which the familiar RMS and peak voltages are readily applicable. The peak-to-peak voltage of a *sine wave* is equal to twice the peak value—that is, it is the same as the total swing. It should be noted, however, that the peak value of any waveform is not necessarily one-half of the peak-to-peak value.

For a given change in brilliancy the CR tube which requires the smallest input voltage is obviously the best to use provided that in all other respects the tubes are equal. The input required ranges between 8 volts p-p to 30 volts p-p with tube types normally employed. The majority need about 20 volts p-p.

Now, the carrier of the television transmitter is modulated from zero to 30 per cent. for the synchronising pulses, and from 30 per cent. to 100 per cent. for the vision signal. The detector output will consequently vary similarly, and, since 30 per cent. modulation corresponds to black and 100 per cent. to white, the peak-to-peak output of vision signal from the receiver, or 70 per cent. of the total output, must correspond to the peak-to-peak modulation input required by the tube. The total output of the receiver (sync + vision) must thus be 1.425 times the input needed by the tube.

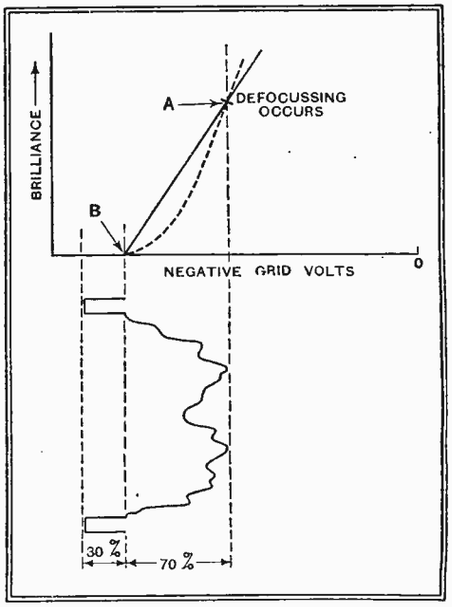

Fig. 1:—The ideal characteristic curve of a CR tube is shown by the straight line, and a practical characteristic by the dotted curve. The signal is applied so that the vision modulation covers the whole of the characteristic and the sync. pulses fall below black.

The ideal tube would have a characteristic connecting grid voltage with brilliancy such as that denoted by the straight line AB in Fig. 1. In this illustration the

[1] *The Wireless World*, January 15th, 1937.

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receiver output is shown below, and it can be seen that the sync pulses should fall to the left of the point B, so that they always fall below black. The vision signals fall between A and B, and as the characteristic is straight the change in brilliancy is proportional to the change in the amplitude of the vision signal.

In practice, the characteristic is not straight, but takes the form shown by the dotted curve passing through the same two points AB. At 30 per cent. and 100 per cent. modulation the correct brilliancy will be secured, but not between these limits. This represents distortion, which may or may not be serious.

The visual effect is to give a loss of detail in dark parts of the picture when the conditions are as in Fig. 1. Since adjustments are made in practice, however, for the best results on the picture that is being transmitted at the moment, these conditions may not be reproduced, and the effects may thus be somewhat different. If the adjustment is carried out on a rather dark picture, a larger input will be used or less grid bias applied, so that good detail is secured. When a brighter picture is received, however, the tube will be overmodulated, and there will be defocusing in the whiter parts, with a consequent loss of detail. We must, therefore, take care to make the adjustments upon a picture which contains both black and white parts so that we can obtain the best compromise between loss of detail in the dark parts and loss of detail in the bright.

The tube requires a positive input, that is, the input voltage must be applied so that it changes in a positive direction with respect to the cathode for increasing modulation depth in the transmitter. This is obtained, if a diode detector feeds the tube directly, by connecting the tube grid to the cathode side of the diode load and the bias source of the tube to the anode side of the load. In other words, the detector anode, not the cathode, must be the earthy side of the circuit. If two vision-frequency stages of amplication follow the detector, the connections must remain the same, but if one stage is used, the detector output connections must be reversed since there is a phase-reversal in each stage of VF amplification. If the correct connections are not adopted, a negative picture will be obtained.

The Frequency Response

Since the input of vision signal required by the tube varies according to the type from 8 volts to 30 volts, the total output of the receiver, including the sync pulses, must be 1.425 times these figures, or 11.4 volts p-p up to 42.8 volts p-p. The input impedance of the tube is reactive corresponding to a capacity of some 5-20 $\mu\mu$F. Tubes vary appreciably in their requirements, so that it will simplify the discussion if we take a particular specimen as a basis, and one which does not fall at either extreme of the range. Let us take the Ediswan 12H tube: this requires an input of about 20 volts p-p and has an input capacity of 15 $\mu\mu$F. Fully to load it on the 70 per cent. modulation of the vision, the receiver must be capable of a total output of 28.5 volts p-p, or say 30 volts p-p, since the figures quoted are only approximate.

The range of frequencies required for perfect reproduction theoretically extends from zero to infinity. Practically, it extends from zero to an arbitrarily defined upper limit which is based on the number of picture elements. The picture is considered as being divided vertically into as many horizontal strips as there are lines, so that the width of each line is taken as the picture height divided by the number of lines. The line is then arbitrarily divided into elements, that is, squares of side equal to the line width. The number of elements in a line is equal to the line length divided by its width, and in the picture to this figure multiplied by the number of lines.

The number of elements in the picture is thus taken as equal to the picture ratio multiplied by the square of the number of lines. The number of elements occurring in one second is thus the number of elements in each picture multiplied by the number of frames per second. The maximum frequency involved is taken as one-half this figure. Written as an equation the calculation becomes—

$$\text{Max. frequency (c/s)} = \text{Picture Ratio} \times \text{No. of frames per sec.} \times (\text{No. of lines per frame})^2 \div 2$$

where the picture ratio is the width divided by the height of the picture. It is 4/3 for Baird and 5/4 for Marconi-E.M.I. transmissions.

For Baird we have, max. frequency = $4 \times 25 \times (240)^2 / (3 \times 2) = 960{,}000$ c/s, while for E.M.I. frequency = $5 \times 25 \times (405)^2 / (4 \times 2) = 2{,}560{,}000$ c/s. Notice that we consider the interlaced E.M.I. transmissions as requiring frequencies equivalent to a plainly scanned picture of 405 lines at 25 frames, not as of 202.5 lines at 50 frames.

Cathode-ray tubes for television receivers being fitted inside metal screens at the Osram-G.E.C. lamp works.

For reception of the Baird transmissions, therefore, our receiver must deal faithfully with all frequencies from zero to 1 Mc/s and for the E.M.I. up to 2.5 Mc/s. Actually, however, it is doubtful whether frequencies higher than 1.5-2.0 Mc/s are being radiated at present, and it appears in practice that it is sufficient to provide an even overall response up to 1.5 Mc/s, especially if the falling off at higher frequencies is gradual so that appreciable output at 2.0 Mc/s is still obtainable.

Since the sound accompaniment to television is transmitted on 41.5 Mc/s as compared with 45.0 Mc/s for the vision, the receiver must be selective enough to attenuate frequencies 3.5 Mc/s different from resonance by some 30-40 db. if interference is to be avoided. The sensitivity required is naturally much more difficult to define since it depends so much upon local conditions, one's distance from Alexandra Palace, and upon the aerial employed. Experience shows, however, that an amplification of 40,000-100,000 times is necessary.

Receiver Characteristics

We can thus sum up the desired receiver characteristics as:—

1. Output = 30 volts p-p.
2. Response "level" from zero to 1.5 Mc/s (drop at 1.5 Mc/s not more than 6.0 db.).
3. Attenuation at 3.5 Mc/s from carrier frequency to be greater than 30.0 db.
4. Voltage amplification = 40,000-100,000 times.

One other preliminary point remains to be discussed, and this is whether the positive or negative of the high-voltage CR tube supply shall be earthed. The supply is usually about 4,500 volts, and the point at which it is earthed is of considerable practical importance since it affects the amount and position of the insulation required.

The deflecting plates must be returned to the third anode through high resistances, and the time-base must itself be earthed for safety's sake. The coupling condensers from the time-base to the deflecting plates, and there are four of them, must be rated for working at 4,500 volts when the nega-

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tive of the tube supply is earthed, but only for low voltage if the positive is earthed. At first sight, therefore, it will be cheaper to earth the positive than the negative end of the supply.

This is not the whole story, however, for with the positive earthed, the mains transformer for the cathode-ray tube heater must have 4,500 volts insulation between windings, and we have also to provide this degree of insulation in the output of the receiver. If the DC component of the vision signal is not retained, this only means that one high-voltage condenser must be provided. It will be shown later, however, that it is very desirable to retain the DC component; with the negative of the supply earthed this leads to no difficulty, but with the positive earthed it means the insulation of the whole detector circuit. This entails the provision of an RF input transformer to the stage with insulation for 4,500 volts, or the feeding of the transformer through condensers of this rating, and also the provision of a mains transformer of high insulation for heating the detector valve. All components for this stage, moreover, must be well boxed up to prevent accidental contact being made with them.

It will be seen, therefore, that if we earth the positive of the CR tube supply we can use low-voltage output condensers from the time-base, but we must provide mains transformers of high insulation for the tube cathode and for the receiver detector valve and insulation for 4,500 volts must be provided throughout the detector circuits. If we earth the negative of the supply, however, we need only provide high-voltage condensers in the time-base output and normal insulation will suffice elsewhere. In particular, the detector heater can be run from the same mains transformer winding as the other valves.

We conclude, therefore, that for television purposes it is easier and cheaper to earth the negative of the high-voltage supply and shall accordingly adopt this arrangement.

NEW BOOKS

La Télévision et ses Progrès. By P. Hemardinquer. Second edition, 335 pp. Published by Dunod, 92, Rue Bonaparte (VI), Paris. Price Fcs.34.60.

THIS book commences by describing the history and essential principles of television and goes on to consider the optical and electrical problems. Most television systems, past and present, are described, and the apparatus at both transmitter and receiver is discussed. The treatment of the subject is non-mathematical and rather elementary.

W. T. C.

Mercury Arcs. By F. J. Teago, D.Sc., M.I.E.E., and J. F. Gill, M.Sc., A.M.I.Mech.E., A.M.I.E.E. Pp. 104 and 49 diagrams. Methuen and Co., Ltd. Price 3s. net.

THIS is a monograph intended for readers of some mathematical and scientific attainments, which gives in concise form the theory and characteristics of the modern mercury arc rectifier. An introductory chapter on the general properties of mercury arcs is followed by a descriptive account of the constructional details of a steel tank rectifier. Succeeding chapters deal with the grid control of voltage and current, current-voltage characteristics, wave-form analysis, transformer ratings and power factor. A particularly interesting chapter is one describing the inverted operation of mercury arc rectifiers, taking energy from a DC source and feeding into an AC system, applications to motor control being referred to.

The authors have succeeded in giving a remarkable amount of information in so small a volume, mainly due to the very lucid and concise mathematical treatment. Errors of any kind are notably few. O. P.

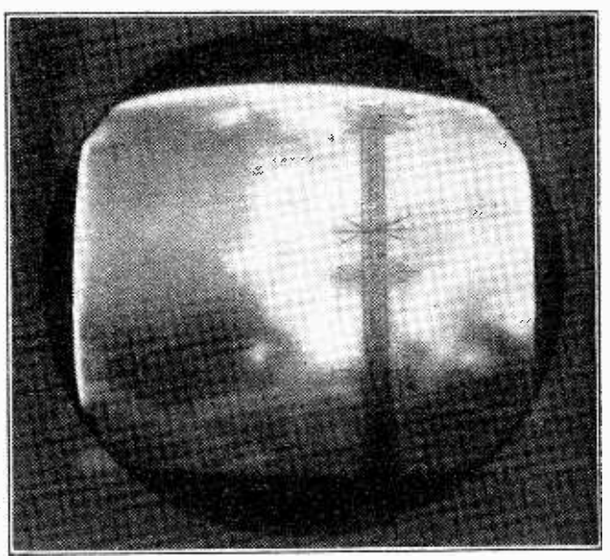
Television Transmissions

Standard System of Scanning

AN announcement, reproduced in full on this page, that there is in future to be only one system of television transmitted from the Alexandra Palace, is not one which need cause any concern to owners of television receivers. Up to the present transmissions have been made during alternate weeks by two different systems for the reception of both of which present receivers have been designed.

The essential differences between these two systems were that in one there were 240 lines and 25 frames, whereas in the other there were 405 lines and 50 frames with interlaced scanning. The former system is being discontinued and all future transmissions will be by the latter.

Having only one system is undoubtedly advantageous in that it will permit some simplification in future receivers to be made. In some quarters optimistic speculations have been made regarding the possibility of a large reduction ensuing in the price of receivers. There would, however, seem no justification for any such expectation, for essentially the simplification amounts only to the omission of two condensers, a change-over switch and a certain amount of wiring. The saving in cost, therefore, is likely to amount to only a few shillings.



THE Postmaster-General announces that, as a result of the experience gained of television transmissions from the London Television Station at Alexandra Palace, the Television Advisory Committee have recommended that the London experimental period—during which different technical standards of transmission have been used during alternate weeks—should now be terminated and that a single set of technical standards should be adopted for public transmissions from the London Station. This recommendation, which has been approved by the Postmaster-General, provides for the adoption of standards as follows :—

Number of lines per picture : 405 interlaced.

Number of frames per second : 50.

Ratio of synchronising impulse to picture : 30 : 70.

These standards for the television service from the London Station will not be substantially altered before the end of 1938.

Consequent upon this decision television transmissions from Alexandra Palace of 240 lines with 25 frames per second will be discontinued, and all future transmissions will be on the standards set out above, which will be known as the London Television standards.

Nevertheless, the change to a single system of transmission is to be welcomed as removing the service a step farther from one of an experimental nature towards the establishment of one on a permanent basis, and we may hope that it will not be long ere television becomes as permanent an institution as sound broadcasting is to-day.

From the technical point of view the future transmissions will take place with 405 lines and 50 frames per second. As interlaced scanning is used this means that the complete picture is scanned 25 times a second with 405 lines, for each of the 50 frames contains 202.5 lines. As compared with sequential scanning the interlacing enables a sufficiently large number of frames to be used to avoid flicker without proportionately increasing the range of modulation frequencies. Modulation frequencies thus do not exceed 2.5 Mc/s.

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Anti-Noise Circuits

ATTACKING THE PROBLEM AT THE RECEIVING END

IN pre-broadcast days it was occasionally difficult to distinguish "man-made" signals from atmospheric interference—the only kind of static (to use the American term) then known. Times have changed, and we are now facing the modern and more serious problem of "man-made" static. Ordinary static comes from the skies and is seldom troublesome in this country—at least, so far as broadcast reception is concerned, whilst the second or artificial variety is being produced closer at hand, and in constantly increasing quantities.

Both forms are alike in the sense that they are definitely aperiodic in character, and so are in a class apart from the kind of interference which can be cured by the use of highly selective circuits. In practice the more selective a circuit is made, the more difficult it becomes to keep it free from aperiodic interference, and this brings about a vicious circle, because the modern broadcast receiver is the last word in selectivity.

Although of very short duration, the train of waves radiated, at close quarters, say from a sparking contact, sets the receiving aerial into forced oscillation at any frequency to which it happens to be tuned. In this way the disturbance thrusts itself into the RF circuits of the receiver and so through the amplifiers into the loud speaker. If the circuits are lightly damped the forced oscillations will persist for some time after the initial impulse has ceased. The amplitude of the disturbance may also be sufficient to overload one or more of the valves, and this, too, may help to prolong the effect of the disturbance by setting up grid currents which are slow to subside.

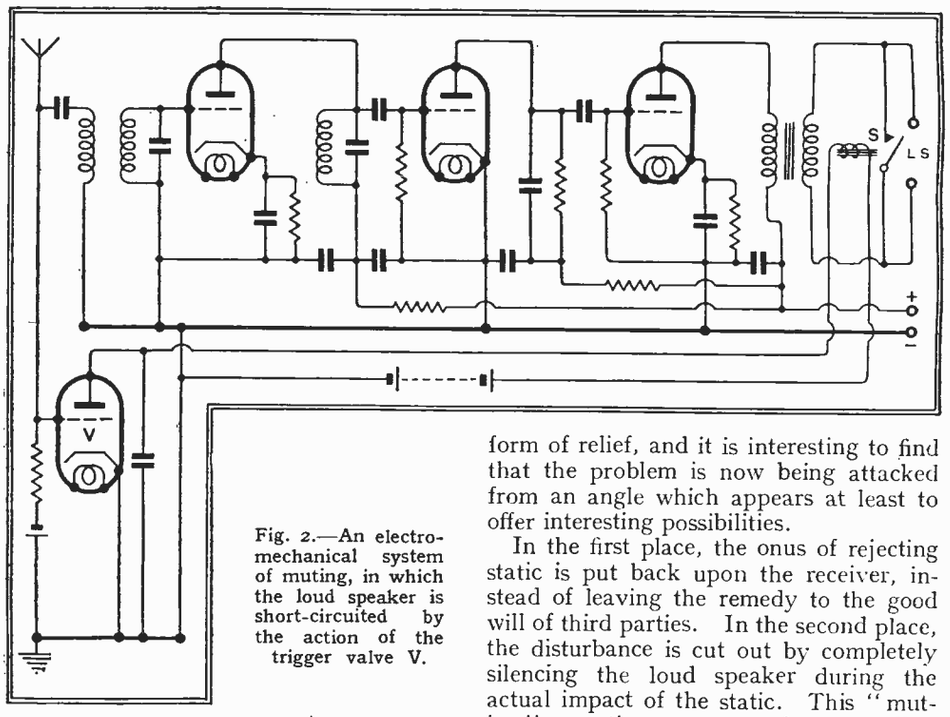

Fig. 2.—An electro-mechanical system of muting, in which the loud speaker is short-circuited by the action of the trigger valve V.

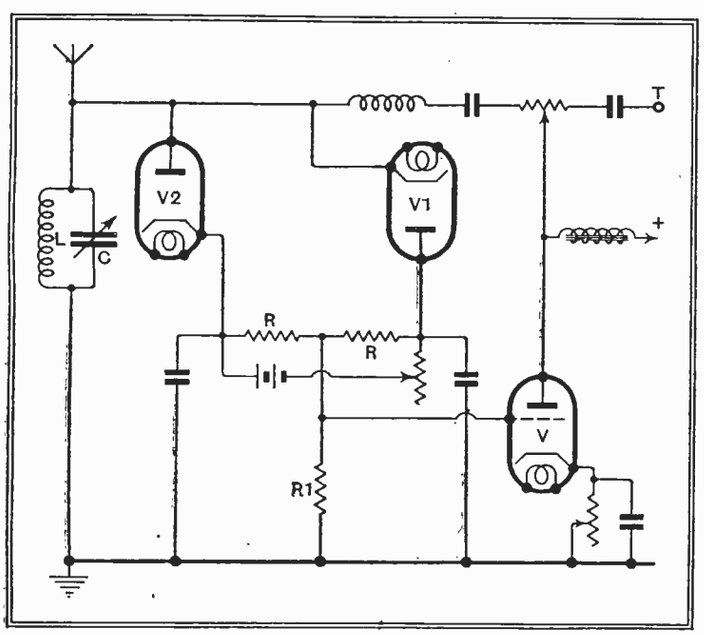

Fig. 1.—A muting system whereby the input circuit is momentarily "shorted" on the incidence of an abnormally strong impulse.

One can argue that if artificial static cannot be kept out of the set it ought to be prevented from getting into the ether in the first place — which means that all spark-producing appliances should be fitted with suppressors. The Post Office is doing its best to educate public opinion on these lines, and is strongly backed by the Committee set up by the I.E.E., which has recently recommended that the sale of any appliance liable to interfere with broadcast reception should be made illegal.

But although prevention is undoubtedly better than cure, we may have to wait a long time for the ether to be completely cleared by force of law. Meanwhile, there is room for some more immediate form of relief, and it is interesting to find that the problem is now being attacked from an angle which appears at least to offer interesting possibilities.

In the first place, the onus of rejecting static is put back upon the receiver, instead of leaving the remedy to the good will of third parties. In the second place, the disturbance is cut out by completely silencing the loud speaker during the actual impact of the static. This "muting" operation must not, of course, affect the apparent continuity of the signal proper.

Imperceptible Gaps

In optics, the well-known kinematographic effect is obtained by deceiving the eye so that it accepts as a smooth continuous movement what is in reality a series of still pictures projected in rapid succession. Provided the interval between one "still" and the next is sufficiently short, the eye does not perceive any gap. In the same way the ear will accept as a smooth continuous sound a signal which may contain short "gaps" of silence. The muted "gaps" are those which would otherwise have carried an impulse of static interference—usually lasting less than the one-thousandth part of a second.

From one point of view the idea is a development of the old method of reducing the effect of atmospherics by means of "limiter" valves, which are used to prevent any interfering surge, no matter how violent, from exceeding the normal strength of the signal. This is now taken a step farther by causing any surge of excessive amplitude to paralyse the first RF valve, so that both signal and interference are immediately shut out from the rest of the receiver. Directly the first

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Anti-Noise Circuits—

shock is over, the paralysing bias is removed and the circuits restored to normal operation.

The effect is secured by using a modified form of the well-known muting circuit employed to give "quiet" interstation tuning. One such arrangement has already been described in *The Wireless World*.[1] In effect it is an AVC system which very rapidly mutes the set directly a strong impulse reaches the aerial and before it has had time to shock-excite the RF circuits, or to overload any of the valves.

Momentary Short Circuit

Another way of obtaining the same effect is to make the static impulse automatically "short" itself across the input circuit of the receiver. Naturally it will simultaneously short the signal, too, but, as before, if the "interruption" is limited to the very brief duration of the initial impact, the ear is not conscious of it.

An arrangement of this type is shown in Fig. 1. The tuned aerial circuit L, C is shunted by a pair of opposed diode valves V1, V2 inserted across the aerial and before the input terminal T of the set proper. Another valve V serves the purpose of completing the muting operation and

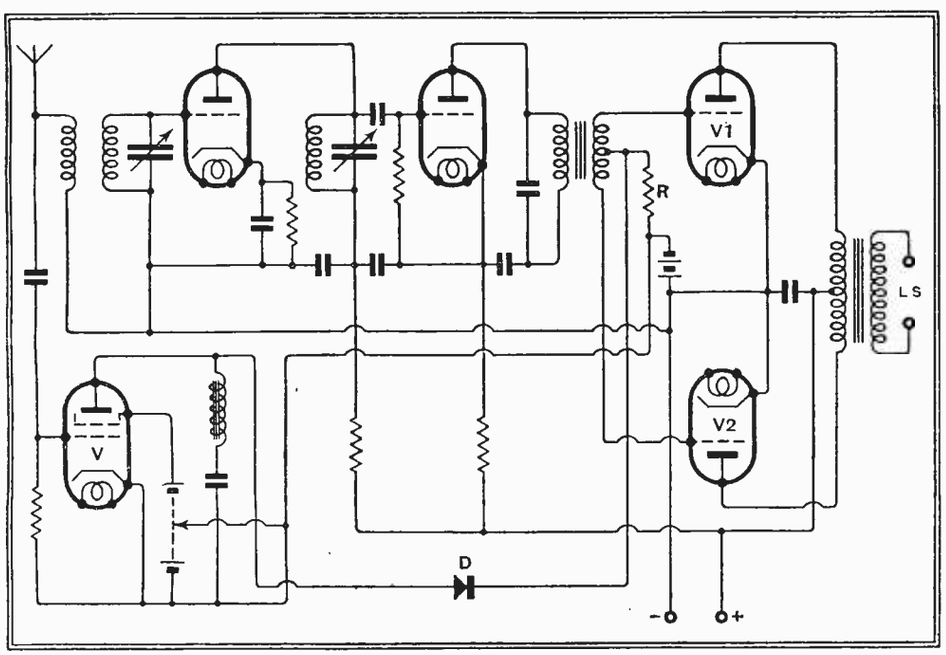

Fig. 3.—An arrangement comparable with Fig. 2, but which operates by applying a paralysing bias.

of rapidly restoring the circuits to normal. The diodes V1, V2 are biased so that they are non-conductive to signals of normal strength, though when a strong impulse strikes the aerial one or other of the pair will pass the excess current, which flows to earth through resistances R, R1.

This alters the grid bias of the valve V so that a current flows in its anode circuit (which includes the lead from the aerial to the input terminal T) in the sense required to balance out the residual signal current flowing from the aerial into the set. Accordingly both static and signal are wiped out, partly by being diverted to earth through the shunt diodes and partly by the effect of the counter-current through the valve V. Directly the impulse has passed, the grid bias of V falls to earth potential, and the whole circuit comes back to normal.

Fig. 2 shows another circuit on somewhat similar lines. In this case the shunt valve V is a gas-filled triode, which, although not conductive to ordinary signals, is set so as to be "triggered" by any strong surge of interference. The resulting discharge operates a quick-action switch S and so short-circuits the speaker. The current passed by the valve V is similar in form to the saw-toothed oscillations used for scanning in television, i.e., it consists of a sharp "peak" which falls rapidly to zero as the impulse passes. The switch S is preferably of the vacuum type, though a break of anything less than 1/50th of a second is said not to be noticeable. In Fig. 3 the switch S has been replaced by a resistance R, through which a paralysing bias is applied by the rapid discharge from a triggered dynatron valve V. A rectifier D prevents the passage of any back-EMF which might tend to overload the AF amplifiers V1, V2.

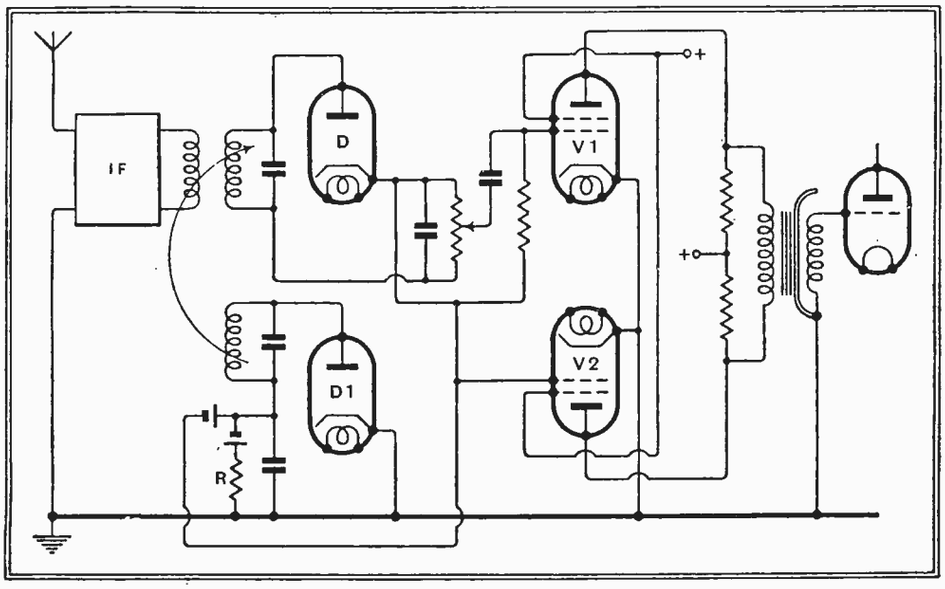

Fig. 4.—A system in which muting is controlled by the output of the IF amplifier of a superhet.

In the superhet receiver shown in Fig. 4 the input coil of the second detector D is coupled to a control diode D1, which develops a potential across its load resistance R as soon as any surge of static reaches it from the IF amplifier. The extra voltage so developed is applied to the grids of the output valves V1, V2, and puts a momentary stop to the passage of both signal and disturbance. As the two AF amplifiers are arranged in push-pull, any tendency for the abrupt stoppage of the anode currents to produce a "click" in the loud speaker is automatically balanced out.

[1] See "Noise Elimination," March 27th, 1936.

The Radio Industry

BRITISH-MADE American-type valves, manufactured to B.V.A. standards, are now included in the Brimar series produced by Standard Telephones and Cables, Ltd. These valves, of which the prices are the same as those of their British equivalents, have hitherto been manufactured for export only.

◆ ◆ ◆ ◆

N. Partridge, B.Sc., A.M.I.E.E., manufacturer of transformers, chokes, etc., has found it necessary to obtain larger premises. These are situated in the same building as formerly; the address is King's Buildings, Dean Stanley Street, London, S.W.1.

◆ ◆ ◆ ◆

The Supreme Instruments Corporation, of Greenwood, Mississippi, U.S.A., has sent us a 60-page manual on the design of testing equipment. Free copies are available for readers.

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UNBIASED

By Free Grid

The Pipe of Domestic Peace

I AM always pleased to place on record anything which redounds to the credit of our wireless manufacturers, or to put forward any evidence to prove that they have been using the brains with which Nature endowed them instead of following each other like a flock of sheep. I therefore take off my hat to Mr. Murphy for his new alphabetical tuning indicator, for it shows that he, at least, has been burning the midnight oil and thinking instead of spending his spare time and cash in the wild Saturnalian orgies of the subterranean night life with which Garden Cities are so notoriously infested.

Unfortunately, however, he is likely to have a rude awakening, for I fear that he greatly overrates the intelligence and educational achievements of broadcast listeners by tacitly assuming that they are familiar with the alphabet. Judging by the ease with which they appear to swallow without protest the guff dished out to them by certain Anglo-Continental stations concerning the functioning of their own internal organs, they will probably pass the new dial over as being intended only for senior wranglers. As for the suggestion that has been made that an alternative dial should be produced with the station names grouped under the countries in which they are situated, of what use is that likely to be to people who meekly accept the statement so insiduously insinuated into their ears by crooners that San Marino is in Italy?

"... intended only for senior wranglers."

However, I feel that I must offer a word of congratulation concerning the shape of the latest sets, which, I feel certain, was thought out by a man who is either married or harassed by women in the shape of acidulous aunts or misanthropic mothers-in-law. The reason is that the cabinet is of the sloping desk type with a narrow ledge on top, and although a console model has not yet appeared, I cannot think that the firm will be so callous as to dash our hopes to the ground by producing a console of some other shape.

You single fellows will, of course, wonder what on earth I am driving at, but, as all men who have had any experience of women in the house will tell you, their one desire when they see a console set or a radio-gram is to stick an aspidistra or some other offensive member of the vegetable kingdom on the top of it, thus obscuring the tuning dial if it is on the top as it should be.

This wretched feminine habit has reached such proportions that many set manufacturers have produced console models with the dials on the front specially for the more timorous type of man who is fearful of hurling the offending plant from its perch and would rather endure the discomfort of tuning when in a horrible squatting position. This new shape of set solves the whole problem at one fell swoop, of course, as the dial is plainly visible and the aspidistra can be placed on the narrow ledge without obscuring anything, and so one model will serve the needs both of he-men and of the other type, while even the womenfolk should be contented, although perhaps it is asking a bit too much to expect that happy consummation.

The radio-gram question remains to be settled, however. A domed-shaped lid would, I fear, incense the women and probably, therefore, a roll-top-desk type of cabinet, with its narrow ledge on top, will have to be adopted.

A Szczebrzeszyn Tragedy

THERE is, I suppose, no piece of apparatus used in our homes that can be considered absolutely fool-proof and therefore utterly devoid of danger. After all, if some silly mutt goes looking for a gas leak with a candle it is no reason for saying that to have a gas supply in the house is dangerous and unsafe. The victim only gets what he deserves, and if he didn't finish himself off that way he would sooner or later come to an equally sticky end by trying to stir the electric fire into greater activity with a poker.

I make these remarks purely to illustrate what fools certain people are making of themselves over the high voltages used in a television receiver. The television receiver is just as safe as the ordinary wireless set if used properly, but, of course, if you go looking for a gas leak with a candle, or in other words, poking into the "innards"

"... so enthralled by the programme ..."

of a set when the juice is on, you will experience just as much discomfort from the few hundred volts of an ordinary mains set as with the few thousand of the television receiver.

Unfortunately, a fresh impetus has just been given to the unwarranted danger-complex which certain foolish and illogical people have with regard to a television set. The cause of this fresh impetus is the untimely end of an unfortunate inhabitant of Poland who possessed artistic tendencies. It appears that at the time of the disaster a Polish experimental television station at Szczebrzeszyn was putting out a programme consisting of an old cinema film of the Figurantes of the Folies Bergere.

The artistic gentleman who became the principal figure in the tragedy was at the time sitting in front of his television receiver twiddling the knobs, and he was so enthralled by the programme that he became lost to the world in more senses than one. Apparently his absorption in his study of line and form became so great that he edged nearer and nearer to the screen of his television receiver in his endeavour to see greater detail, until eventually his nose was flattened against the end of the cathode-ray tube like that of a small boy looking into a confectioner's shop window.

Now cathode-ray tubes are pretty tough things and their ends are made to stand up to all sorts of stresses and strains, but unfortunately this proved just a shade too much for this particular one, as it suddenly caved in and precipitated our artistic friend's face against the high voltage anode. The widow is now suing the proprietors of the television station for damages, but as the matter is still *sub judice* I am, of course, prevented from making any comments on it.

An Important Announcement

I MUST apologise for the non-appearance of the commentary which I expected to give on the recent "1922 Scrapbook," but unfortunately I am prevented from giving it for very grave reasons indeed. Insidious subterranean forces have been at work to cut short my activities in this direction, and I hope to be in a position to make startling revelations concerning them next week.

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CURRENT TOPICS

EVENTS OF THE WEEK IN BRIEF REVIEW

New Wireless Telephony Service

THE G.P.O. are to experiment with the use of ultra-short waves as a telephony link between the mainland and the Orkney and Shetland Isles. It is particularly desired to ascertain whether the system is suitable for use at all periods of the year.

Italy's Short-wave Plans

TWO new short-wave transmitters, each having a power of 100 kilowatts, are to be erected in Italy, and the two existing 25-kW transmitters are to have their power increased to 40 kW. Special directional aerials are to be erected for the purpose of transmitting programmes to various selected parts of the world. In addition an experimental 50-kW transmitter is to be built for testing new aerial arrangements and for exploring the possibilities of various wavelengths.

Malayan Pioneer Closes Down

THE Malayan Government have decided to close down the Singapore ZHI station. This station has been operated for a number of years by a band of amateur enthusiasts and provided entertainment for the first owners of receiving sets in Malaya. The decision to terminate the station's licence is due to the establishment of the British Malayan Broadcasting Corporation's new station at Singapore.

Higher Power for U.S. Broadcasting?

IN the course of a report recently submitted to the Federal Communications Commission by American broadcasting engineers, it is proposed that twenty-five new super-power stations be erected in suitable parts of the country and that the power of existing stations be considerably increased. Furthermore, an extension of the waveband allotted to broadcasting is suggested in order to allow for a great increase in the number of broadcasting stations.

Improving Austrian Stations

THE Austrian broadcasting authorities have decided to increase the power of the Graz station from 7 kW to 15 kW. They have also under consideration the question of the power of the Vienna short-wave station, which now employs 1½ kW. The station has recently been re-equipped, but the authorities are quite prepared to make still more improvements if its range during the present testing period does not prove to be satisfactory.

A.R.R.L. Founder Honoured

THE average person in this country associates the name of Maxim with machine guns rather than with wireless. In the U.S.A., however, the name is chiefly remembered because a descendant of the Maxim of machine-gun fame was an enthusiastic radio amateur who founded the American Radio Relay League in 1914. The son and daughter of the late founder of the League have perpetuated their father's memory by establishing an annual award to be given to the amateur under twenty-one years of age who has made the greatest contribution to amateur radio during the year.

More Pay for Wireless Workers

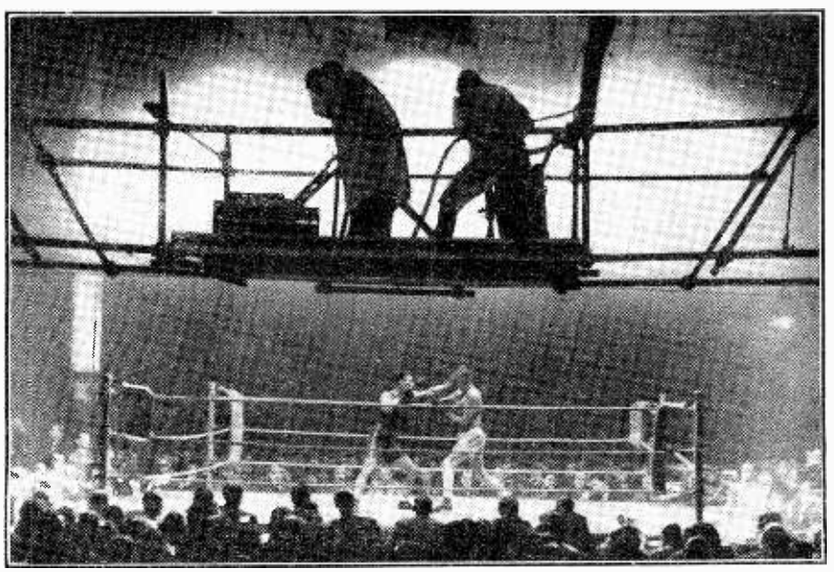
THE general rise in wages and salaries which has of late taken place in Italy has been extended to the radio industry. The pay of both manual and clerical workers has been increased by 10 per cent.

New German P.M.G.

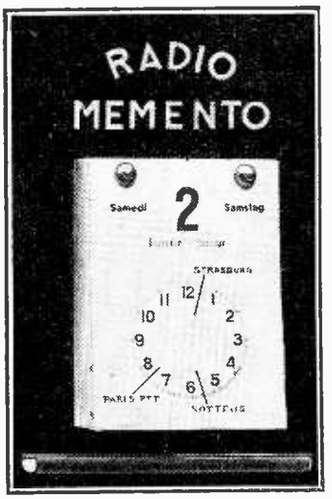
HERR OHNESORGE, an erstwhile chief of the German P.O. laboratories, has been appointed Minister of Posts. Despite his name, Herr Ohnesorge will probably find that, with the development of television and other wireless activities, his job is far from being a sinecure.

Germany and Television Research

THE television laboratories of the German P.O. have now been severed from the other scientific research sections. The laboratories will, however, remain under the direction of Dr. Banneitz, although they now form an independent unit. New premises are to be equipped at Kleinmachnow, which is situated at some distance from Berlin.



FIRST FULL-DRESS TELEVISION O.B. A new thrill came to viewers last week when they saw and heard the Amateur Boxing Tournament televised from the ring at the Alexandra Palace. This was the first occasion on which an actual "show," open to the public, has been televised. The photograph shows the suspended cradle with the television camera-man at work during the broadcast. That the public is interested in such a transmission is borne out by the fact that in one West End hotel nearly 150 guests saw the fight through one receiver



A RADIO REMINDER PAD has just been published in Switzerland. It is intended for making notes of the times of special items listeners wish to tune in.

Wireless-controlled Aeroplanes

DRAMATIC scenes of an air-raid on London by a fleet of wireless-controlled bombing planes were recently staged for the purpose of the making of a film called "Midnight Menace" by Grosvenor Sound Films, Ltd., a British firm. The apparatus for controlling the planes is an exact replica of that used for manœuvring the R.A.F. "Queen Bee" wireless-controlled planes.

Verboten

WHILE the manufacture of apparatus capable of causing interference to broadcasting is still legal in this country, things are far different in Austria. Dr. Taucher, the Minister of Commercial Affairs, has just published an order in the official Austrian Gazette forbidding the manufacture and the sale of "unsuppressed" apparatus.

Woman Announcers Disappearing?

THE famous woman announcers of Italy are receding more and more into the background, their activities being now restricted to the actual programme announcements. The reading of the news bulletins is now undertaken by men. The well-known Rome announcer, Maria Luisa Boncompagni, who is the doyenne of European woman announcers and has been at the Rome station for over ten years, has now been moved to Turin.

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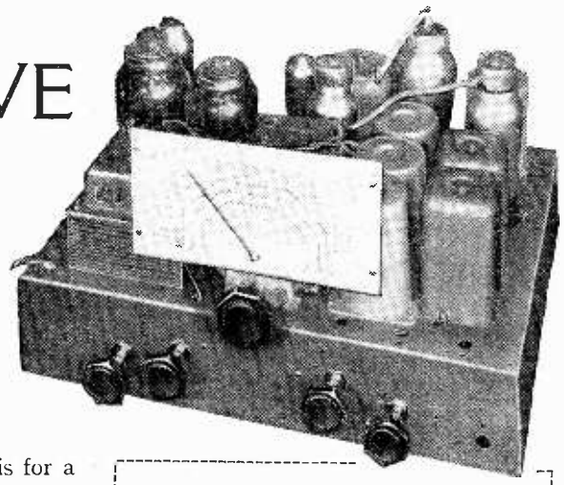
Scientific 8-VALVE Superhet

AN ALL-WAVE AC-OPERATED RECEIVER IN CHASSIS FORM



COMPLETE receivers are offered to the public in such wide variety that it is not usually difficult to find a model with a specification suited to individual requirements. There are, however, instances where the standardised receiver fails to fill the bill. To make this point it is only necessary to cite two cases: (1) where it is desired to build a receiver into a cabinet of special design; (2) where there is a predilection for one particular make of loud speaker.

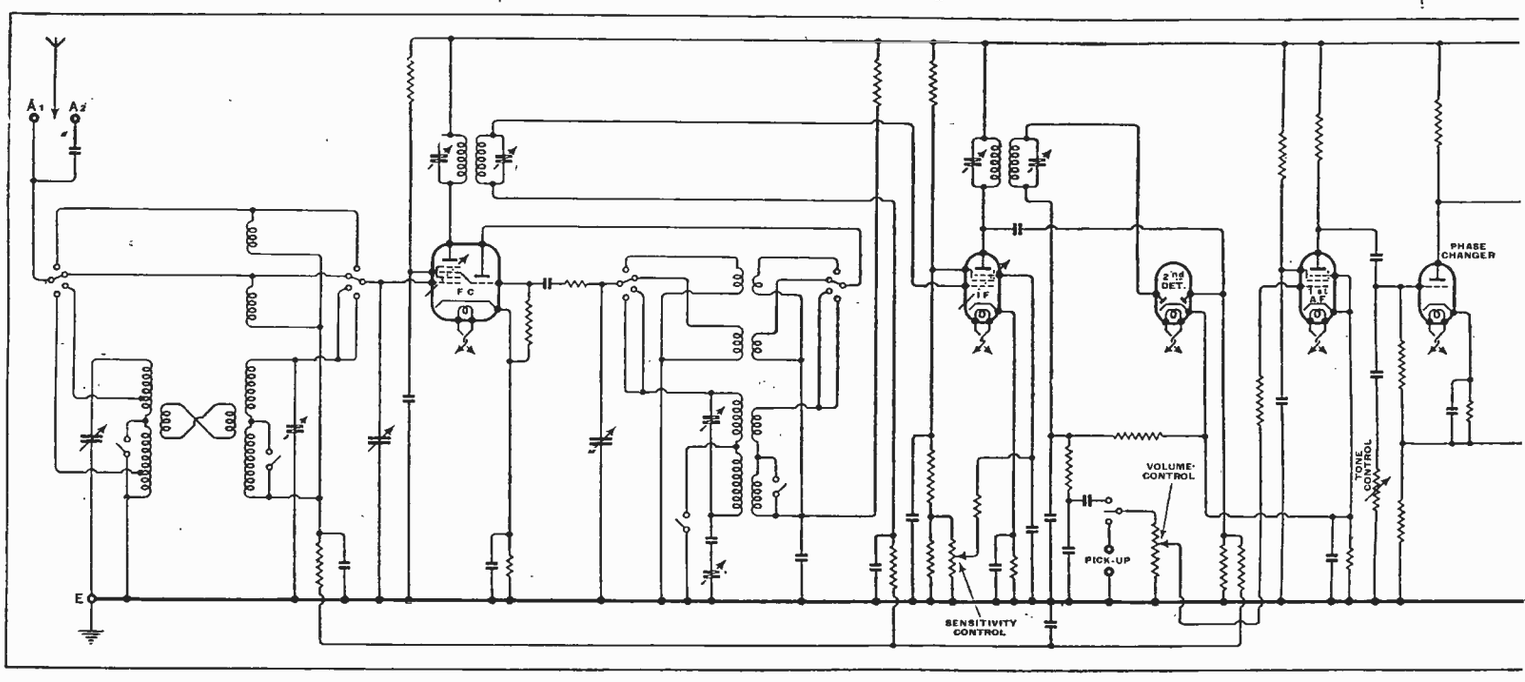
The receiver units marketed by the Scientific Supply Stores (Wireless) Ltd. give a performance in the matter of range and selectivity which is comparable with the best complete receivers, and starting from this foundation the purchaser is left with full scope for the development of his own ideas in the matter of cabinet design and loud speaker reproduction. The example chosen for review is the 8-valve 4-band all-wave chassis. In addition to the normal medium- and long-wave broadcast bands there are two short waveranges covering 13 to 35 and 35 to 81 metres respectively. AVC is, of course, included, and the push-pull triode output stage is rated to give an output of 6 watts. There is provision for the addition of a gramophone pick-up, so that with its high output the chassis can be used as the basis for a full-sized radio-gramophone.

The eight valves in the circuit include the rectifier. There is no amplification at signal frequency, and the first stage is a triode-hexode frequency-changer. This is preceded on medium and long waves by a link-coupled band-pass filter and on the two short-wave ranges by a single tuned circuit. Alternative aerial tappings are provided to give two degrees of selectivity according to circumstances. The single IF amplifier is a variable-mu RF pentode in which an unusual form of sensitivity control has been adopted. The suppressor grid, instead of being returned directly to earth, is taken to a potentiometer supplying a small positive bias. The second detector which also provides AVC is a double-diode, separate first-stage AF amplification being provided by an RF-type pentode. This is resistance-coupled to a triode phase-changing valve preceding the resistance-coupled push-pull output valves. Tone control is effected by a variable RC circuit across the input resistance to the phase-changer valve.

FEATURES. — ***Type.***—*Superheterodyne chassis for AC mains.* ***Waveranges.***—*(1) 13-35 metres. (2) 35-81 metres. (3) 200-550 metres. (4) 800-2,000 metres.* ***Circuit.***—*Triode-hexode frequency-changer —var.-mu pentode IF amplifier — double-diode second detector—pentode AF amplifier —triode push-pull output valves. Full-wave valve rectifier.* ***Controls.***—*(1) Tuning. (2) Volume and on-off switch. (3) Tone. (4) Sensitivity. (5) Waverange.* ***Price.***—*£10 17s. 6d. (with valves but without loud speaker).* ***Makers.*** — *Scientific Supply Stores (Wireless) Ltd., 126, Newington Causeway, London, S.E.1.*

The HT supply is derived from a full-wave valve rectifier, and a smoothing choke or field winding with a resistance of 1,250 ohms will be required. The loud speaker input transformer will, of course, be of the centre-tapped type and should have a ratio such that the load across the anode is of the order of 12,000 ohms. There are terminals for an external loud

The circuit is interesting for the unusual method of sensitivity control in the IF stage. There are three AF stages after the second detector.



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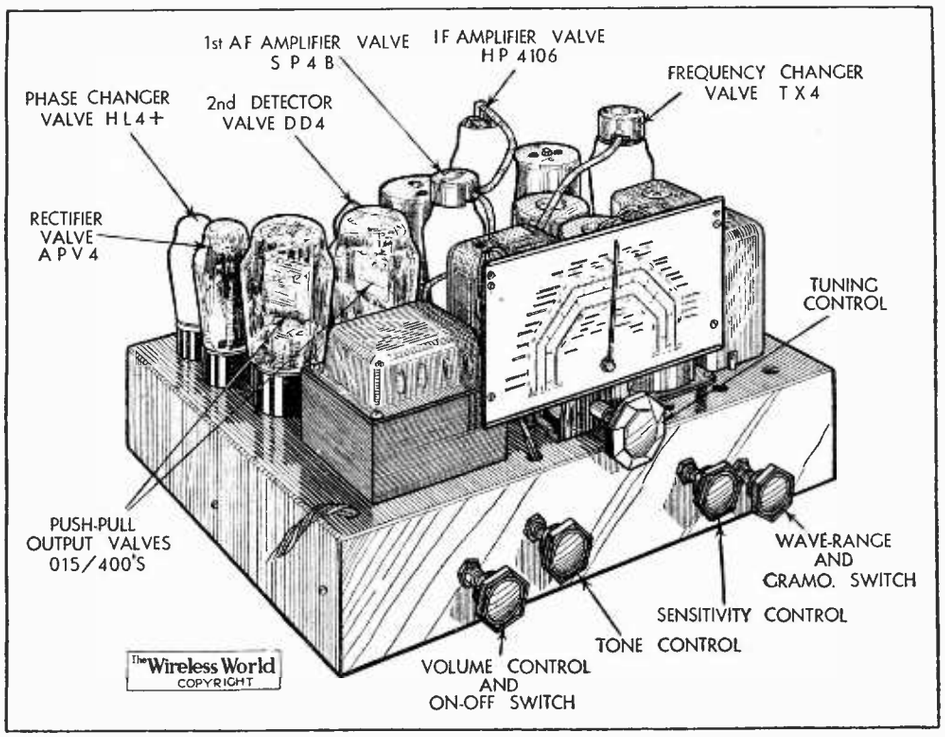
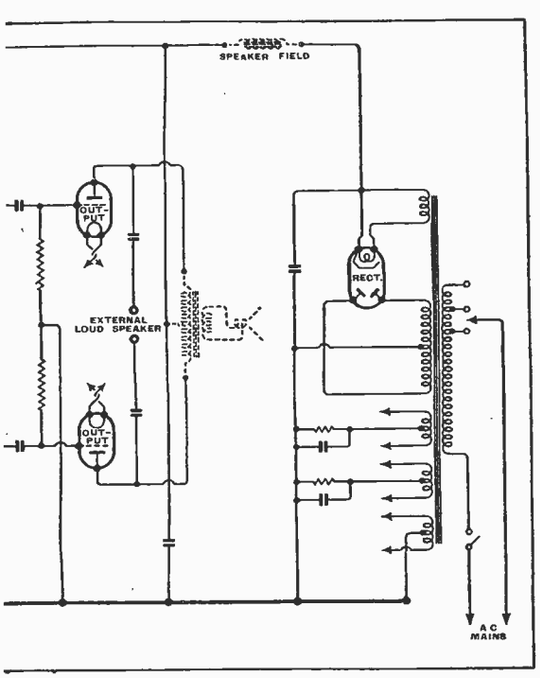
speaker which is connected through by-pass condensers in parallel with the primary winding of the main output transformer. The receiver is built on a light but rigid spot-welded steel chassis finished in grey enamel.

The valves throughout are of Tungsram manufacture and all the components are of British design and make. The wave-range switch is of the rotary low-capacity type and should give long and reliable service. The tuning dial is calibrated with a selection of station names on medium and long waves, and on the short waves the regions where broadcast transmissions are most likely to be found are clearly indicated.


1st A F AMPLIFIER VALVE S P 4 B
I F AMPLIFIER VALVE H P 4106
FREQUENCY CHANGER VALVE T X 4
PHASE CHANGER VALVE H L 4+
2nd DETECTOR VALVE D D 4
RECTIFIER VALVE A P V 4
TUNING CONTROL
PUSH-PULL OUTPUT VALVES 015/400'S
WAVE-RANGE AND GRAMO. SWITCH
SENSITIVITY CONTROL
TONE CONTROL
VOLUME CONTROL AND ON-OFF SWITCH
The Wireless World COPYRIGHT

General view showing positions of valves and layout of controls in the Scientific 8-valve chassis.



No one will have cause to complain of the range and sensitivity of this receiver on any of the four wavebands. The selectivity on long waves is sufficient to give easy separation of the Deutschland-sender from Droitwich and Radio-Paris, and with the tone control brought into operation the sideband splash is brought down to the irreducible minimum. On the medium waveband less than one channel is lost on either side of the London Regional station when using the set in Central London, so that one can be sure of extracting the maximum number of useful transmissions from this waveband. There was a second channel whistle at about 475 metres, but otherwise the medium waveband was clear.

On long waves a few feeble whistles were distributed throughout the range, but they were not sufficient to cause interference with any worthwhile station. Near the bottom end of the scale on this range there was a point where tunable interference from London Regional occurred, probably on account of an oscillator harmonic.

Short-wave Performance

When tuning on the two short wave-ranges the ratio of the slow-motion dial might be regarded as rather too low, but this criticism is to some extent off-set by the fact that a fairly large diameter tuning knob has been provided. In the absence of RF amplification, and the preselection which it implies, double tuning points are obtained for each station. Conditions were not particularly good for long-distance reception when we tested the set, but, nevertheless, a reliable programme was received from Bound Brook (W3XAL), 16.87 metres. At first some difficulty was experienced in inducing the oscillator to function on the shortest wavelengths, but this was found to be due to lack of HT volts, and was easily remedied by moving the mains voltage adjustment down one step.

There can be little doubt that this chassis represents excellent value for money, and if the construction shows evidence of economies at various points, these are not of a nature which is likely to affect either the performance or reliability of the set.

News from the Clubs

The Croydon Radio Society

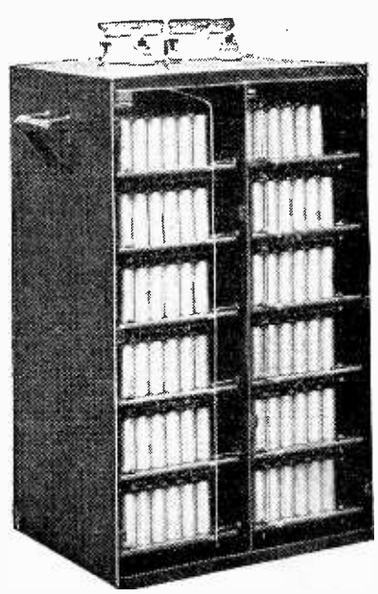
An entertaining lecture was recently given on "Modern Sound Film Technique" by Mr. W. J. Bird, the Chairman of the Society. Full details of the Club's activities and particulars of future lectures may be obtained from the Hon. Pub. Secretary, Mr. E. L. Cumbers, 14, Campden Road, S. Croydon.

The Halifax Experimental Radio Society

A somewhat unusual evening was spent by the above Society recently when a transmitting station situated three miles away was used in conjunction with a receiver at the Society's headquarters to demonstrate the ability of the amateur transmitter to deal with a large variety of broadcasts. Speech and music, and also the relaying of song birds from a neighbouring aviary, were undertaken by the transmitter. The Hon. Secretary, Mr. J. B. Bedford, Oak House, Triangle, near Halifax, Yorkshire, will be pleased to give full particulars concerning the Society to enquirers.

The Southall Radio Society

An out-of-the-ordinary type of lecture was recently given by Mr. G. M. Fox, Ve3DG, and Mr. G. Pipe, Ve3JX, on "Contrasts between Radio Practice in Great Britain and in the U.S.A. and Canada." This and a lecture on 10-metre working by Mr. H. V. Wilkins, G6WN, aroused an unusual degree of interest. The Society holds meetings every Tuesday at 8.15 p.m. at the Southall library, Osterley Park Road, Southall (five minutes from the G.W.R. station). Readers who care to send a three-halfpenny stamp to the Hon. Sec., Mr. H. F. Reeve, 26, Green Drive, Southall, will receive a complete programme of the Society's activities for the coming session.



HIGH CAPACITY.—A bank of T.C.C. wet electrolytic condensers totalling 2,500 mfds. designed for working at 600 volts DC.

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Broadcast Brevities

NEWS FROM PORTLAND PLACE

Before and After the Coronation

FULLY alive to the risk that the Coronation Week broadcasts may outshine all others, the B.B.C. has already arranged that the early summer broadcasts, both before and after the national celebrations, shall provide an appropriate setting.

Coronation Week itself—May 9th to 15th—will be preceded by a series of highspots.

The Academy Banquet

On May 1st there is the Cup Final broadcast from Wembley, and on May 3rd the Royal Academy Dinner, one of the few public banquets which can always be relied upon to produce oratory worthy of the best of loud speakers.

Toscanini

The Royal Opera season will be in full swing at Covent Garden throughout May and June, and among the operas to be broadcast will be "Otello," "Alceste," "Aida," "Die Valkyrie," "Don Giovanni" and "The Magic Flute."

Another "London Music Festival" will be held under B.B.C. auspices during the latter half of May, and it is expected that the great Toscanini himself will conduct two or three of the concerts.

Paul Robeson ?

On the lighter side there is to be a gala show featuring Laddie Cliff and Stanley Lupino, and a performance of "The Emperor Jones," in which it is hoped that Paul Robeson will take part.

Review of the Fleet

Meanwhile the "O.B." Department is already at work with a towel round its head, arranging time-tables and chartering land lines for the biggest series of outside "hook-ups" in B.B.C. history. Apart from the Coronation, the most important and most difficult of all, perhaps, will be the broadcast of the King's Review of the Fleet at Spithead on May 20th. Fortunately, the "O.B." men will profit by their experience in broadcasting the Royal Review in 1935, when a short-wave link was established between a B.B.C. launch and an old look-out tower at Southsea.

The Aldershot Tattoo and the ceremony of Trooping the Colour will be the highlights in June; and, of course, there will be the Wimbledon tennis championships as well as the Horse Show at Olympia.

Empire Programme from India

Two other important events in May: An Empire Day programme to be relayed from India, and a special Jutland feature programme on the last day of the month to mark the twenty-first anniversary of the battle.

CORONATION PREPARATIONS This photograph was taken outside Wellington Barracks during a tour of inspection by B.B.C. and C.B.S. officials to find suitable places for commentators of the Columbia Broadcasting System on the route of the Coronation procession. In the car from left to right are: Mr. C. Saerchinger, C.B.S. London representative, Mr. R. H. Wood, B.B.C. Engineer-in-Charge of London O.B.'s, and Mr. John Snagge, the well-known B.B.C. commentator.

Extending the Television Service

That sweeping changes will take place at Alexandra Palace in the next few weeks need not be doubted. The possibility of having at least four studios in constant operation is already being canvassed, for with such facilities it should be comparatively easy to maintain continuous production without programme intervals and with much more elaborate "sets."

Even the prospect of three sessions daily instead of two becomes less terrifying, and it is also possible to contemplate television on Sundays. Stand by for an interesting announcement.

Meanwhile, round-table conferences are now masticating the co-axial cable question in preparation for an ambitious series of "O.B.s" during the coming summer. Apart from the cable constructed primarily for the Post Office telephone services, there are now some fourteen miles of "co-axial" in existence in this country for the exclusive use of television, including the six-mile length between Alexandra Palace and Broadcasting House.

The problem at the moment is whether it is advisable to manufacture more of this expensive commodity—it costs at least £1,000 per mile—before it has been tried out in practice.

Scottish Youth in Judgment

IF the opinions of the youth of Scotland have any weight at all, the B.B.C. will have soon to revise its programme policy very considerably in order to cater for the young idea in the way that the young idea desires. Take the voting at the recent Youth Conference in Edinburgh, organised by the Corporation. The delegates, all between fourteen and eighteen years of age, plumped heavily for variety programmes, broadcasts of important happenings, plays, dance bands, light orchestral music, running commentaries and brass and military bands, in that order.

But serious orchestral music appealed to only twenty of the delegates, fifty-four voted against it, while for twenty-six it held no interest. Men soloists had forty-seven votes in favour and twenty-eight against, while twenty-five abstained from voting. Women soloists, on the other hand, found only thirteen supporters, forty-eight opponents, and thirty-nine delegates did not vote, the inference being again that these were not sufficiently interested. Crooners received thirty-three votes; fifty-three voted for their abolition and fourteen did not vote. One would have thought that bagpipe music would receive a hundred per cent. vote from such a conference. So far from that being the case, only forty-two young Scots admitted to finding pleasure in that form of music, thirty-three did not want any of it, and twenty-five were completely detached and did not trouble to vote. For talks and discussions the voting was fairly evenly divided. But variety got it with a bang—ninety-two votes out of a possible hundred.

Relay Services and Schools: A Warning

COMMITTEES are usually more outspoken than individuals, and the Central Council for School Broadcasting adheres to the tradition in a candid warning just issued to school authorities who may be considering the use of a local relay service for the reception of school broadcasts.

After recommending that schoolmasters should ensure that the school broadcasts are relayed in their entirety, the Council states that it is necessary to ascertain that the service will provide satisfactory reproduction under school conditions.

The Question of Volume

Schoolmasters are reminded that the relay services cater primarily for the private listener; it has been found by schools that the relays do not always provide sufficient volume of sound even in a classroom of moderate size unless an additional amplifier is installed.

The interesting suggestion is made that, if a local education authority is considering the connection of several of its schools to a relay system, arrangements should be made for one school to be wired first as an experiment. In fact, the Council goes so far as to undertake to stage comparative demonstrations between relay reception and by reception direct on a set giving a good standard of quality.

A Slip of the Pen, Mon

IN a moment of aberration the writer stated in these columns a fortnight ago that B.B.C. premises converted from private houses included the new Penmon transmitter. This is, of course, wrong. But the North Wales headquarters of the B.B.C. occupies a former private dwelling in Bangor, near the University.

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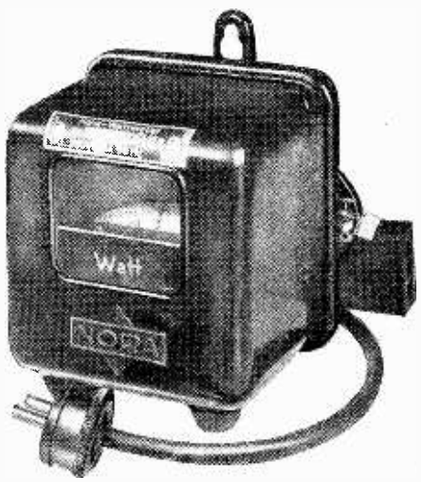
New Apparatus Reviewed

NORA WATTMETER

THOUGH it may be a comparatively easy matter to measure the apparent AC power in Volt-Amps. consumed by a gramophone motor, a radio receiver and other electrical devices used in radio, the quantity so obtained rarely gives anything like a true indication of the actual power taken



Nora Wattmeter for use on AC circuits.

from the supply mains. To obtain the true value on AC supplies recourse generally has to be made to a suitably designed wattmeter.

An instrument that has a range that enables measurements to be made with convenient scale readings with the comparatively low-power electrical devices used in radio has been introduced by Londex, Ltd., Brettenham House, Lancaster Place, Strand, London, W.C.2. It is known as the Nora wattmeter and has a range of 0-180 watts. The meter is of German manufacture and is enclosed in a metal case similar in design to that used on house lighting and power supply circuits.

The indicator is a circular disc mounted horizontally and rotating on a centre pivot. An inclined mirror is used to enable the scale to be viewed through the front window.

A cable and two-pin plug of five-amp. size is fitted for connection to the supply point, and on the side of the case is a two-pin socket to which the mains lead from the set or other device under test is joined.

Tests show the accuracy of the instrument to be well within the limits required for the purpose of measuring the consumption of wireless receivers; although the error naturally tends to increase at very low wattages, accuracy is well maintained down to the lowest value likely to be dealt with.

It is a sturdily made instrument and costs £3 3s.

HUNT'S CONDENSER

THE range of fixed condensers made by A. H. Hunt, Ltd., Bendon Valley, Garratt Lane, Wandsworth, London, S.W.18, is particularly comprehensive, for the various types made cover almost every requirement of the set designer and home constructor.

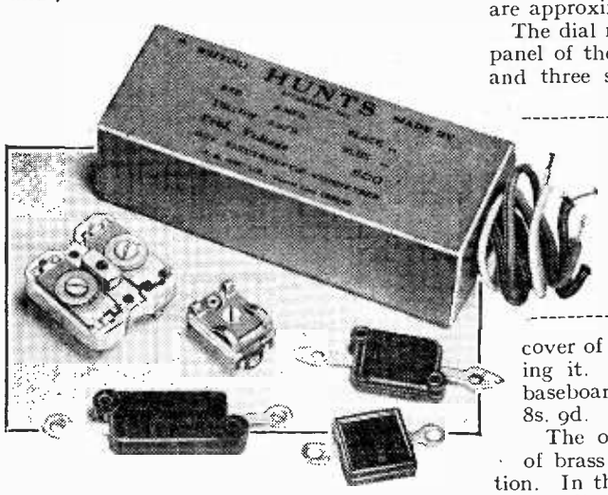
RECENT PRODUCTS OF THE MANUFACTURERS

There is a large variety of electrolytic models in dry and wet types; some are assembled in waxed cartons, while others are in aluminium cases for chassis mounting.

Multiple types, consisting of two or more separate condensers, as well as some with the negative or positive poles joined to a common lead, are now available. The electrolytic series alone comprises about 180 different models. In addition, there are paper-dielectric condensers in metal cases and in tubular containers, as well as a long series of mica condensers in moulded cases. Several specimens have been tested, and in every case the measured capacity was well within the usual tolerance for the particular type.

We have also examined and tested some of Hunt's trimmer and padding condensers. One model, the Type TD, is a dual pattern on a ceramic base, and is of the kind used in the construction of IF transformers and similar components. Each condenser is of the compression type with mica dielectric. These are available in maximum capacities of from 70 to 900 m-mfds., and cost from 2s. to 3s. according to size.

Midget trimmers on bakelite or on ceramic bases are also made in single models of from 10 to 180 m-mfds. maximum, while the bakelite models can be obtained with up to six separate trimmers mounted on a single strip. A four-section model, for example, with condensers variable between 5 and 70 m-mfds., costs 2s. 8d.



Selection of Hunt's fixed condensers, showing a dual-capacity dry electrolytic, mica types and padding condensers on ceramic bases.

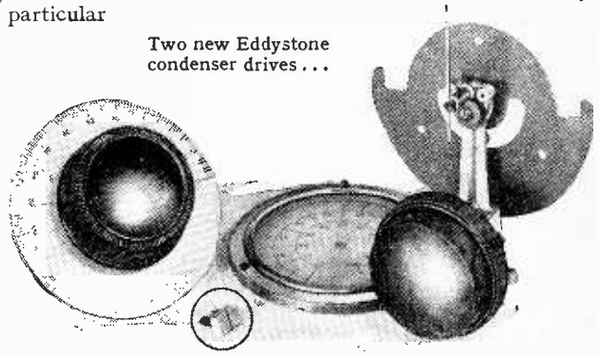
The small moulded mica fixed condensers are made in all the usual sizes, from 0.00005 mfd. to 0.01 mfd., and range in price from 6d. to 2s. each.

EDDYSTONE DIALS

TWO new condenser drives have recently been introduced by Stratton & Co., Ltd., Eddystone Works, Bromsgrove Street, Birmingham. One is a two-ratio model mainly intended for use on all-wave and short-wave receivers, while the other is possibly best described as an instrument dial, as it can be included in the category of precision apparatus.

One interesting feature of the two-speed dial is that the pointer has a travel of 310 degrees, thereby giving a very open scale for the 180-degree movement of the condenser. The scale is divided into 100 graduations and scale and pointer are protected by a circular glass cover. It is a friction-drive dial and the main rotor is made of a bakelised material which is very

Two new Eddystone condenser drives . . .



. . . one is a two-ratio model with glass front, and the other an instrument-type model.

tough. The elimination of as many metal parts as possible in the driving mechanism is a useful feature, as it goes a long way towards reducing the possible causes of noise in short-wave sets. The two ratios provided are approximately 20 to 1 and 100 to 1.

The dial mechanism is located behind the panel of the set, and two ¼in. or ⅜in. holes and three small holes for fixing the glass cover of the scale only are needed for fixing it. Provision is made for panel or baseboard mounting. This dial costs 8s. 9d.

The other model is made throughout of brass and is of very robust construction. In this case the dial, which measures 4in. in diameter and on which a 0-100 scale is engraved, rotates and a small indicator with a line engraved on it is supplied for fixing to the panel.

This model can be supplied with two different styles of condenser fitting; in the one case a spindle is fitted, while in the other the end is hollow and has two grub screws to take a ¼in. spindle.

The ratio is 6 to 1 and the price is 15s.

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PRINCIPAL BROADCASTING STATIONS OF EUROPE

Arranged in Order of Frequency and Wavelength

(This list is included in the first issue of each month. Stations with an Aerial Power of 50 kW. and above in heavy type)

Station.	kc/s.	Tuning Positions.	Metres.	kW.
Ankara (Turkey)	153		1961	5
Kaunas (Lithuania)	153		1961	7
Brasov (Radio Romania) (Romania)	160		1875	150
Hilversum No. 1 (Holland) (10 *kW.* till 1440)	160		1875	100
Lahti (Finland)	166		1807	150
Moscow, No. 1, RW1 (Komintern) (U.S.S.R.)	172		1744	500
Paris (Radio Paris) (France)	182		1648	80
Istanbul (Turkey)	185		1622	5
Irkutsk (U.S.S.R.)	187.5		1600	20
Deutschlandsender (Germany)	191		1571	60
Droitwich	200		1500	150
Minsk, RW10 (U.S.S.R.)	208		1442	35
Reykjavik (Iceland)	208		1442	16
Motala (Sweden)	216		1389	150
Novosibirsk, RW76 (U.S.S.R.)	217.5		1379	100
Warsaw, No. 1 (Poland)	224		1339	120
Luxembourg	232		1293	150
Leningrad, No. 1 RW53 (Kolpino) (U.S.S.R.)	232		1293	100
Kalundborg (Denmark)	240		1250	60
Vienna, No. 2 (Austria)	240		1250	0.5
Vigra (Aalesund) (Norway)	253		1186	10
Tashkent, RW11 (U.S.S.R.)	256.4		1170	25
Oslo (Norway)	260		1153.8	60
Moscow, No. 2, RW49 (Stchelkovo) (U.S.S.R.)	271		1107	100
Tromsö (Norway)	282		1064	10
Tiflis, RW7 (U.S.S.R.)	283		1060	35
Sarator (U.S.S.R.)	340		882.3	20
Finmark (Norway)	347		864	10
Archangel (U.S.S.R.)	350		857.1	10
Rostov-on-Don, RW12 (U.S.S.R.)	355		845.1	20
Budapest, No. 2 (Hungary)	359.5		834.5	18
Sverdlovsk, RW5 (U.S.S.R.)	375		800	40
Boden (Sweden)	392		765	0.6
Banska-Bystrica (Czechoslovakia) (15 *kW.* after 1700)	392		765	30
Geneva (Switzerland)	401		748	1.3
Moscow, No. 3 (RCZ) (U.S.S.R.)	401		748	100
Ostersund (Sweden)	413.5		726	0.6
Voronejc, RW25 (U.S.S.R.)	413.5		726	10
Oulu (Finland)	431		696	1.2
Hamar (Norway)	519		578	0.7
Innsbruck (Austria)	519		578	1
Tartu (Estonia)	522		575	0.5
Ljubljana (Yugoslavia)	527		569.3	6.3
Viipuri (Finland)	527		569.3	10
Bolzano (Italy)	536		559.7	10
Wilno (Poland)	536		559.7	16
Budapest, No. 1 (Hungary)	546		549.5	120
Beromünster (Switzerland)	556		539.6	100
Athlone (Irish Free State)	565		531	60
Klaipeda (Lithuania)	565		531	10
Palermo (Italy)	565		531	3
Stuttgart (Germany)	574		522.6	100
Alpes-Grenoble, P.T.T. (France)	583		514.6	15
Madona (Latvia)	583		514.6	50
Vienna No. 1 (Austria)	592		506.8	100
Rabat (Morocco)	601		499.2	25
Sundsvall (Sweden)	601		499.2	10
Florence (Italy)	610		491.8	20
Cairo, No. 1 (Egypt)	620		483.9	20
Brussels, No. 1 (Belgium)	620		483.9	15
Lisbon (Portugal)	629		476.9	15
Tröndelag (Norway)	629		476.9	20
Prague, No. 1 (Czechoslovakia)	638		470.2	120
Lyons, P.T.T. (France)	648		463	100
Petrozavodsk (U.S.S.R.)	648		463	10
Cologne (Germany)	658		455.9	100
North Regional (Slaithwaite)	668		449.1	70
Sottens (Switzerland)	677		443.1	100
Belgrade (Yugoslavia)	686		437.3	2.5
Paris, P.T.T. (France)	695		431.7	120
Stockholm (Sweden)	704		426.1	55
Rome, No. 1 (Italy)	713		420.8	50
Kharkov, No. 1, RW20 (U.S.S.R.)	722		415.4	10
Fredrikstad (Norway)	722		415.4	1
Tallinn (Estonia)	731		410.4	20
Madrid, EAJ2 (Spain)	731		410.4	3
Seville (Spain)	731		410.4	5.5
Munich (Germany)	740		405.4	100
Marseilles, P.T.T. (France)	749		400.5	90
Pori (Finland)	749		400.5	1
Katowice (Poland)	758		395.8	12
Scottish Regional (Falkirk)	767		391.1	70
North Scottish Regional (Burghead)	767		391.1	60
Stalino (U.S.S.R.)	776		386.6	10
Toulouse P.T.T. (France)	776		386.6	120
Leipzig (Germany)	785		382.2	120
Barcelona, EAJ1 (Spain)	795		377.4	7.5
Lwow (Poland)	795		377.4	50
Penmon (Wales)	804		373.1	5
West Regional (Washford Cross)	804		373.1	70
Milan, No. 1 (Italy)	814		368.6	50
Bucharest (Romania)	823		364.5	12
Kiev, RW9 (U.S.S.R.)	832		360.6	35
Agen (France)	832		360.6	0.5
Berlin (Germany)	841		356.7	100
Norwegian Relay Stations	850		352.9	—
Sofia (Bulgaria)	850		352.9	1
Valencia (Spain)	850		352.9	3
Simferopol, RW52 (U.S.S.R.)	859		349.2	10
Strasbourg (France)	859		349.2	100
Poznan (Poland)	868		345.6	16
London Regional (Brookmans Park)	877		342.1	70
Linz (Austria)	886		338.6	15
Graz (Austria)	886		338.6	7.5
Helsinki (Finland)	895		335.2	10
Limoges, P.T.T. (France)	895		335.2	1.5
Hamburg (Germany)	904		331.9	100
Dniepropetrovsk (U.S.S.R.)	913		328.6	10
Toulouse (Radio Toulouse) (France)	913		328.6	60
Brno (Czechoslovakia)	922		325.4	32
Brussels, No. 2 (Belgium)	932		321.9	15
Algiers (Algeria)	941		318.8	12
Göteborg (Sweden)	941		318.8	10
Breslau (Germany)	950		315.8	100
Paris (Poste Parisien) (France)	959		312.8	60
Bordeaux-Sud-Ouest (France)	968		309.9	30
Odessa (U.S.S.R.)	968		309.9	10
Northern Ireland Regional (Lisburn)	977		307.1	100
Genoa (Italy)	986		304.3	10
Torun (Poland)	986		304.3	24
Hilversum No. 2 (Holland). (15 *kW.* till 1540)	995		301.5	60
Bratislava (Czechoslovakia)	1004		298.8	13.5
Midland Regional (Droitwich)	1013		296.2	70
Chernigov (U.S.S.R.)	1013		296.2	4
Barcelona, EAJ15 (Spain)	1022		293.5	3
Cracow (Poland)	1022		293.5	2
Oviedo (Spain)	1022		293.5	0.7
Königsberg No. 1 (Heilsberg) (Germany)	1031		291	100
Parede (Portugal)	1031		291	5
Leningrad, No. 2, RW70 (U.S.S.R.)	1040		288.5	10
Rennes-Bretagne (France)	1040		288.5	120
Scottish National (Falkirk)	1050		285.7	50
Bari No. 1 (Italy)	1059		283.3	20
Paris (Radio Cité) (France)	1068		280.9	0.8
Tiraspol, RW57 (U.S.S.R.)	1068		280.9	10
Bordeaux-Lafayette (France)	1077		278.6	12
Zagreb (Yugoslavia)	1086		276.2	0.7
Falun (Sweden)	1086		276.2	2
Madrid, EAJ7 (Spain)	1095		274	5
Vinnitsa (U.S.S.R.)	1095		274	10
Kuldiga (Latvia)	1104		271.7	50
Naples (Italy)	1104		271.7	1.5
Moravska-Ostrava (Czechoslovakia)	1113		269.5	11.2
Fécamp (Radio Normandie) (France)	1113		269.5	10
Alexandria, No. 1 (Egypt)	1122		267.4	0.25
Newcastle	1122		267.4	1
Nyiregyhaza (Hungary)	1122		267.4	6.25
Hörby (Sweden)	1131		265.3	10
Turin, No. 1 (Italy)	1140		263.2	7
Trieste (Italy)	1140		263.2	10
London National (Brookmans Park)	1149		261.1	20
North National (Slaithwaite)	1149		261.1	20
West National (Washford Cross)	1149		261.1	20
Kosice (Czechoslovakia)	1158		259.1	10
Monte Ceneri (Switzerland)	1167		257.1	15
Copenhagen (Denmark)	1176		255.1	10
Nice-Corse (France)	1185		253.2	60
Frankfurt (*and Relays*) (Germany)	1195		251	25
Prague, No. 2 (Czechoslovakia)	1204		249.2	5
Lille, P.T.T. (France)	1213		247.3	60
Bologna (Radio Marconi) (Italy)	1222		245.5	50
Narvik (Norway)	1222		245.5	0.3
Gleiwitz (Germany)	1231		243.7	5
Cork (Irish Free State)	1240		241.9	1
Saarbrücken (Germany)	1249		240.2	17
Riga (Latvia)	1258		238.5	10
Rome, No. 3 (Italy)	1258		238.5	1
San Sebastian, EAJ8 (Spain)	1258		238.5	1
Nürnberg (Germany)	1267		236.8	2
Juan-les-Pins (Radio Côte d'Azur) (France)	1276		235.1	27
Christiansand (Norway)	1276		235.1	0.5
Dresden (Germany)	1285		233.5	0.25
Aberdeen	1285		233.5	1
Klagenfurt (Austria)	1294		231.8	5
Vorarlberg (Austria)	1294		231.8	5
Danzig	1303		230.2	0.5
Swedish Relay Stations	1312		228.7	—

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Station.	kc/s.	Tuning Positions.	Metres.	kW.
Magyarovar (Hungary)	1321	.....	227.1	1.25
German Relay Stations	1330	.....	225.6	—
Montpellier, P.T.T. (France)	1339	.....	224	1.2
Lodz (Poland)	1339	.....	224	2
Dublin (Irish Free State)	1348	.....	222.6	0.5
Rjukan (Norway)	1348	.....	222.6	0.15
Salzburg (Austria)	1348	.....	222.6	2
Tampere (Finland)	1348	.....	222.6	0.7
Cairo No. 2 (Egypt)	1348	.....	222.6	0.5
Königsberg (Germany)	1348	.....	222.6	2
Nottoden (Norway)	1357	.....	221.1	0.15
Italian Relay Stations	1357	.....	221.1	—
L'Ile de France (France)	1366	.....	219.6	0.7
Basle (Switzerland)	1375	.....	218.2	0.5
Berne (Switzerland)	1375	.....	218.2	0.5
Warsaw, No. 2 (Poland)	1384	.....	216.8	2
Lyons (Radio Lyons) (France)	1393	.....	215.4	25
Stara-Zagora (Bulgaria)	1402	.....	214	2
Vaasa-Vasa (Finland)	1420	.....	211.3	0.5
Alexandria, No. 2 (Egypt)	1429	.....	209.9	0.5
Turku (Finland)	1429	.....	209.9	0.5
Miskolc (Hungary)	1438	.....	208.6	1.25
Paris (Eiffel Tower) (France)	1456	.....	206	5
Pecs (Hungary)	1465	.....	204.8	1.25
Antwerp (Belgium)	1465	.....	204.8	0.1
Courtrai (Belgium)	1465	.....	204.8	0.1
Bournemouth	1474	.....	203.5	1
Plymouth	1474	.....	203.5	0.3
Binche (Belgium)	1487	.....	201.7	0.1
Chatelineau (Belgium)	1492	.....	201.1	0.1
Wallonia (Belgium)	1492	.....	201.1	0.1
Nimes (France)	1492	.....	201.1	0.7
Albacete (Spain)	1492	.....	201.1	0.2
Santiago (Spain)	1492	.....	201.1	0.5
Liege (Radio Cointe) (Belgium)	1500	.....	200	0.1
Verviers (Belgium)	1500	.....	200	0.1
Pietarsaari (Finland)	1500	.....	200	0.25
Radio Alcalá (Spain)	1500	.....	200	0.2
Karlskrona (Sweden)	1530	.....	196	0.2
Liepàja (Latvia)	1737	.....	173	0.1

SHORT-WAVE STATIONS OF THE WORLD

Station.	Call Sign.	kc/s.	Tuning Positions.	Metres.	kW.
Batavia (Java)	YDA	3,040	.....	98.68	10
Ponta Delgada (Azores)	CT2AJ	4,000	.....	75.00	0.05
Kharbarovsk (Russia)	RV15	4,273	.....	70.20	20
Caracas (Venezuela)	YV2RC	5,800	.....	51.72	1
San Jose (Costa Rica)	TIGPH	5,820	.....	51.52	—
Maracaibo (Venezuela)	YV5RMO	5,850	.....	51.28	—
Vatican City (Vatican State)	HVJ	5,970	.....	50.26	10
Trujillo (Domenica)	H1X	5,980	.....	50.16	0.2
Mexico City (Mexico)	XEBT	6,000	.....	50.00	1
Moscow (Russia)	RW59	6,000	.....	50.00	20
Montreal (Canada)	CFCX	6,005	.....	49.96	0.07
Havana (Cuba)	COCO	6,010	.....	49.92	0.5
Prague (Podebrady) (Czechoslovakia)	OLR	6,010	.....	49.92	30
Singapore (Malaya)	ZHI	6,018	.....	49.85	0.09
Bogota (Colombia)	HJ3ABH	6,018	.....	49.85	1.6
Zeesen (Germany)	**DJC**	6,020	.....	49.83	50
Panama City (Panama)	HP5B	6,030	.....	49.75	0.1
Calgary (Canada)	VE9CA	6,030	.....	49.75	0.1
Boston (U.S.A.)	W1XAL	6,040	.....	49.67	10
Miami (U.S.A.)	W4XB	6,040	.....	49.67	2.5
Barranquilla (Colombia)	HJ1ABG	6,042	.....	49.65	0.15
Daventry (Gt. Britain)	GSA	6,050	.....	49.59	15
Cincinnati (U.S.A.)	W8XAL	6,060	.....	49.50	10
Philadelphia (U.S.A.)	W3XAU	6,060	.....	49.50	10
Skamlebaek (Denmark)	OXY	6,060	.....	49.50	0.5
Manizales (Colombia)	HJ4ABL	6,070	.....	49.45	0.15
Penang (Malaya)	ZHJ	6,080	.....	49.34	0.05
Chicago (U.S.A.)	W9XAA	6,080	.....	49.34	0.5
Nairobi (Kenya)	VQ7LO	6,083	.....	49.31	0.5
Bowmanville (Canada)	CRCX	6,090	.....	49.26	0.5
Hong Kong (China)	ZBW2	6,090	.....	49.26	2
Johannesburg (South Africa)	ZTJ	6,100	.....	49.20	5
Bound Brook (U.S.A.)	W3XAL	6,100	.....	49.18	35
Chicago (U.S.A.)	W9XF	6,100	.....	49.18	10
Belgrade (Yugoslavia)	.....	6,100	.....	49.18	1
Manizales (Colombia)	HJ4ABB	6,105	.....	49.15	0.3
Daventry (Gt. Britain)	GSL	6,110	.....	49.10	15
Calcutta (India)	VUC	6,110	.....	49.10	0.5
Wayne (U.S.A.)	W2XE	6,120	.....	49.02	1
Havana (Cuba)	COCD	6,130	.....	48.92	0.25
Halifax (Canada)	VE9HX	6,130	.....	48.92	0.2
Pittsburgh (U.S.A.)	W8XK	6,140	.....	48.86	40
Winnipeg (Canada)	CJRO	6,150	.....	48.78	2
Lisbon (Portugal)	CSL	6,150	.....	48.78	0.50
Caracas (Venezuela)	YV3RC	6,150	.....	48.78	—
Parede (Portugal)	CT1GO	6,200	.....	48.40	5
Trujillo (Domenica)	H1Z	6,320	.....	47.50	—
Caracas (Venezuela)	YV4RC	6,375	.....	47.05	—
San Jose (Costa Rica)	TIPG	6,410	.....	46.80	0.5
Barranquilla (Colombia)	HJ1ABB	6,450	.....	46.52	1
Valencia (Colombia)	YV6RV	6,520	.....	46.00	0.5
Riobamba (Ecuador)	PRADO	6,620	.....	45.31	—
Guayaquil (Ecuador)	HC2RL	6,670	.....	45.00	0.2
Amateurs	.....	7,000 to 7,300	.....	42.86 to 41.10	0.01
Moscow (U.S.S.R.)	RV96	7,520	.....	39.89	20
Prangins (Radio-Nations) (Switz'l'd)	HBP	7,780	.....	38.48	20
Quito (Ecuador)	HCJB	8,210	.....	36.50	0.25
Budapest (Hungary)	HAT4	9,125	.....	32.88	5
Havana (Cuba)	COCH	9,430	.....	31.80	—
Rio de Janeiro (Brazil)	PRF5	9,500	.....	31.58	5
Daventry (Gt. Britain)	GSB	9,510	.....	31.55	15
Melbourne (Australia)	VK3ME	9,510	.....	31.55	1.5
Hongkong (China)	ZBW3	9,520	.....	31.49	2
Jelöy (Norway)	LKJ1	9,530	.....	31.48	1
Schenectady (U.S.A.)	W2XAF	9,530	.....	31.48	30
Tokio (Japan)	JZI	9,530	.....	31.48	20
Zeesen (Germany)	**DJN**	9,540	.....	31.45	50
Suva (Fiji)	VPD2	9,542	.....	31.45	—
Zeesen (Germany)	**DJA**	9,560	.....	31.38	50
Bombay (India)	VUB	9,565	.....	31.36	4.5
Millis (U.S.A.)	W1XK	9,570	.....	31.35	10
Daventry (Gt. Britain)	GSC	9,580	.....	31.32	15
Lyndhurst (Australia)	VK3LR	9,580	.....	31.32	1
Philadelphia (U.S.A.)	W3XAU	9,590	.....	31.28	10
Sydney (Australia)	VK2ME	9,590	.....	31.28	20
Eindhoven (Holland)	PCJ	9,590	.....	31.28	20
Prangins (Radio-Nations) (Switz'l'd)	HBL	9,595	.....	31.27	20
Moscow (Russia)	RAN	9,600	.....	31.25	20
Rome (Italy)	2RO	9,635	.....	31.13	25
Sourabaya (Java)	YDB	9,650	.....	31.09	1
Lisbon (Portugal)	CT1AA	9,655	.....	31.09	2
Buenos Aires (Argentina)	LRX	9,660	.....	31.06	5
Lisbon (Portugal)	CT1CT	9,680	.....	31.00	0.5
Madrid (Spain)	EAQ	9,860	.....	30.43	20
Bandoeng (Java)	PMN	10,260	.....	29.24	3
Ruysselede (Belgium)	ORK	10,330	.....	29.04	9
Bandoeng (Java)	PLP	11,010	.....	27.25	3
Stockholm (Sweden)	SM5SX	11,700	.....	25.63	0.5
Winnipeg (Canada)	CJRX	11,720	.....	25.60	2
Paris (Radio-Colonial) (France)	TPA4	11,720	.....	25.60	12
Daventry (Gt. Britain)	GSD	11,750	.....	25.53	15
Zeesen (Germany)	**DJD**	11,770	.....	25.49	50
Boston (U.S.A.)	W1XAL	11,790	.....	25.45	10
Vienna (Austria)	OER2	11,800	.....	25.42	1.5
Rome (Italy)	2RO	11,810	.....	25.40	25
Daventry (Gt. Britain)	GSN	11,820	.....	25.38	15
Wayne (U.S.A.)	W2XE	11,830	.....	25.36	1
Lisbon (Portugal)	CT1AA	11,830	.....	25.38	2
Daventry (Gt. Britain)	GSE	11,860	.....	25.29	15
Pittsburgh (U.S.A.)	W8XK	11,870	.....	25.27	40
Paris (Radio-Colonial) (France)	TPA3	11,880	.....	25.23	12
Moscow (Russia)	RNE	12,000	.....	25.00	20
Lisbon (Portugal)	CT1CT	12,082	.....	24.83	0.5
Reykjavik (Iceland)	TFJ	12,235	.....	24.52	7.5
Parede (Portugal)	CT1GO	12,400	.....	24.20	0.35
Warsaw (Poland)	SPW	13,635	.....	22.00	10
Amateurs	.....	14,000 to 14,400	.....	21.42 to 20.84	0.01
Sofia (Bulgaria)	LZA	14,970	.....	20.04	7
Zeesen (Germany)	**DJL**	15,111	.....	19.85	50
Vatican City (Vatican State)	HVJ	15,123	.....	19.84	10
Daventry (Gt. Britain)	GSF	15,140	.....	19.82	10
Daventry (Gt. Britain)	GSO	15,180	.....	19.76	10
Hongkong (China)	ZBW4	15,190	.....	19.75	2
Zeesen (Germany)	**DJB**	15,200	.....	19.74	50
Pittsburgh (U.S.A.)	W8XK	15,210	.....	19.72	40
Eindhoven (Holland)	PCJ	15,220	.....	19.71	20
Paris (Radio-Colonial) (France)	TPA2	15,243	.....	19.68	12
Daventry (Gt. Britain)	GSI	15,260	.....	19.65	10
Wayne (U.S.A.)	W2XE	15,270	.....	19.65	1
Zeesen (Germany)	**DJQ**	15,280	.....	19.63	50
Buenos Aires (Argentina)	LRU	15,290	.....	19.62	5
Daventry (Gt. Britain)	GSP	15,310	.....	19.60	10
Schenectady (U.S.A.)	W2XAD	15,330	.....	19.57	18
Budapest (Szekesfehervar) (Hungary)	HAS3	15,370	.....	19.52	26
Zeesen (Germany)	**DJE**	17,760	.....	16.89	50
Wayne (U.S.A.)	W2XE	17,760	.....	16.89	1
Bound Brook (U.S.A.)	W3XAL	17,780	.....	16.87	35
Daventry (Gt. Britain)	GSG	17,790	.....	16.86	10
Bandoeng (Java)	**PLE**	18,830	.....	15.93	60
Daventry (Gt. Britain)	GSH	21,470	.....	13.97	10
Wayne (U.S.A.)	W2XE	21,520	.....	13.94	1
Daventry (Gt. Britain)	GSJ	21,530	.....	13.93	10
Pittsburgh (U.S.A.)	W8XK	21,540	.....	13.93	40

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Listeners' Guide fo

THE second of the series of special programmes by the B.B.C. Variety Orchestra, under the heading "Intermission," will be given to-night (Friday) at 6 (Reg.) from St. George's Hall. In this series individual musicians in the orchestra demonstrate their skill as solo instrumentalists. On this occasion, among others to be heard will be Norman Hester, who has been bass player of the orchestra since it was formed, playing his "magnum opus" which he has just produced. This is the first modern rhythmic solo for this unwieldy instrument. In America the bass is called the bull fiddle, and with this at the back of his mind Norman Hester has christened his composition "The Bull Steps Out," in which the accompaniment is provided by a piano and guitar.

Though St. George's Hall is acoustically ideal for such a "down in the depths" solo, Teddy Gower, the B.B.C. balance official for the Variety Orchestra, may justifiably regard it as a balance test piece. Listeners who hear this programme will have an unusual opportunity for testing their receivers on their reproduction of the lower register.

◈ ◈ ◈

"THE TABLE UNDER THE TREE"

A NEW version of Wilfrid Rooke-Ley's "The Table Under the Tree," produced by A. W. Hanson, will be heard by Regional listeners at 7.5 on Sunday. As before, the scene is a garden of a café—somewhere in Europe—famous among travellers for its good wine, good music, and good company. It is a summer evening and the garden is filled with a holiday crowd of many nationalities. The orchestra plays, the voice of a famous singer is heard, and at one of the tables—the table under the tree—three people sit and talk, a young man and woman and an elderly gentleman in a black cloak.

The part of the singer will be taken by Percy Manchester and that of the elderly gentleman by the author. Continental music will be provided by Walford Hyden and his orchestra.

WALFORD HYDEN and his orchestra, which is heard in the Café Colette programmes, will supply the essential background of Continental music for "The Table Under the Tree" on Sunday.

◈ ◈ ◈

EXAMINATIONS

THE subject of the "Northern Cockpit" discussion which is to be broadcast Regionally on Tuesday at 8.15 will be Examinations. The subject is one on which most people hold decided views, and in this discussion there will be contributions by speakers drawn from various walks of life. For example, a mother of a ten-year-old child will complain that her offspring is forced to overwork in order to gain admittance to a Senior Central School, and an elementary school teacher will express sympathy with the mother, but will explain that teachers are always trying to ensure that no child is overworked. A business man will also contribute by giving his experience of boys and girls who seek employment on leaving school.

MUSIC

THE Sunday Orchestral Concert this week, at 9.5 (Reg.), will be conducted by Nikolai Malko, the well-known Russian conductor. The programme will include the "Turcoman Suite" by Schechter and Tchaikovsky's rarely heard First Symphony (Winter Rêverie). Airs from Glinka's "Russlan and Ludmilla," and Moussorgsky's "Boris Godunov" will be sung by Oda Slobodskaya. Madame Slobodskaya was formerly leading dramatic soprano at the Imperial Opera, Petrograd, but after the Revolution she left Russia and went to Berlin.

Earlier on Sunday, at 4.30 (Nat.), Aylmer Buesst will conduct the incidental music to "King Lear," composed by Haydn when he was Kapellmeister to Prince Estherhazy. The manuscript score of this music has recently been discovered by Dr. Karl Geiringer, of Vienna, and it will be remembered that the Overture was broadcast in December.

The programme for the Symphony Concert from the Queen's Hall on Wednesday consists of Purcell's "Chaconne" and Bax's Sixth Symphony for the first relay, from 8.15 to 9.5 (Nat.). The second part of the concert, which follows at 9.25, brings the Prokofiev Violin Concerto No. 1, in which Joseph Szigeti will be the soloist, and Stravinsky's "Rite of Spring."

There will be an interesting broadcast on Thursday in the Regional programme of works which were awarded prizes in the Australian Composers' Competition, 1934-5. This competition was organised by the Australian Broadcasting Commission and the works selected are a trio for violin, 'cello and pianoforte by Margaret Sutherland, a string quartet by Clive Douglas and a group of songs by Fritz Hart, who is co-director of the Melbourne Symphony Orchestra. The songs will be sung by Etta Bernard, the Australian contralto, and the concerted works will be played by the Norbert Wethmar Pianoforte Quartet and Pauline Juler (clarinet).

Details of the week's Television programmes will be found on p. 153.

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DRAMA

THE story of Antony's fatal love for Cleopatra inspired Shakespeare to write one of his finest tragedies, and nearly a century later Dryden wrote "All for Love; or, The World Well Lost: a tragedy written in imitation of Shakespeare's style." In the National programme on Sunday, at 5.35, listeners will hear Peter Creswell's production of the latter play. The music, from contemporary sources, is arranged by Julian Herbage, who will also conduct the orchestra. Fay Compton will play the part of Cleopatra, Maurice Colbourne that of Antony, and Mary Hinton that of Octavia (Antony's wife).

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COMMENTARIES

A VARIETY of sports commentaries are to be given to National listeners on Saturday afternoon. From 2.35 to 4.20 (approx.) Captain Wakelam will describe the Rugby struggle between England and Ireland at Twickenham. For a quarter of an hour immediately following this the venue will be Paddington Baths, where the progress of the Junior Singles Final of the English National Open Table Tennis Championship will be described. Then at 4.35 (approx.) listeners will be switched over to Selhurst Park, where F. N. S. Creek, the old Corinthian, will give a fifteen-minute commentary on the final stages of the Soccer match between the British and French Armies.

A week or two back mention

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The Week

Outstanding Broadcasts at Home and Abroad

was made in these pages of a relay from an ice hockey match at Harringay. Many readers must have been disappointed on tuning in to find an entirely different O.B. This was due to a subsequent change in the programme arrangements, and those who were then disappointed will be glad to know that on Wednesday at 9.30 (Reg.) a half-hour's description of the play during the first day of the World Ice Hockey Championships will be given from Wembley.

BY REQUEST

A CONCERT in aid of the German Winter Help Fund will be broadcast from Deutschlandsender at 7 on Sunday. A feature of the fund is that each donor is entitled to request an item for these concerts. As donations are received from all parts of Europe the programme which comprises requests should be an interesting one.

CHILDREN'S CHOIR

THE Eschweiler Singschar (choir), which consists of about one hundred boys and girls, all of whom are members of the Hitler Youth Organisation, will give a concert entitled "To Sing Cheerfully, do we begin," which will be broadcast from Berlin at 8 on Tuesday.

OPERA

LOVERS of opera have a rather small selection from which to make their choice for listening times this week. To-night (Friday), Haydn's "Der Apotheker" comes from Frankfurt at 8, and at the same time Paris PTT relays "Monna Vanna" (Février) from the Opéra.

On Saturday Verdi's three-act "La Traviata" will be relayed from the Teatro Carlo Felice, Genoa, by Milan 1, at 8. An interesting programme of excerpts from Puccini's operas is billed by Stuttgart for 7.10 on the same evening, when the soloists will be Hildegarde Ranczak (soprano) and Peter Anders (tenor). Among the operas included are "La Bohême," "Madam Butterfly," "The Girl of the Golden West," and "Turandot."

A studio performance of Puccini's "La Bohême," with Hendrich Steiner as conductor, will be broadcast by Berlin at 7 on Sunday.

From the Municipal Casino, Cannes, on Monday at 8.45, Nice relays Wagner's "Tristan and Isolde."

FOLK DANCING

THERE is a feature in the Danish programmes to-night (Friday) at 9.20, which should be well worth tuning in. It is an O.B. from the Haandverkerforeningen Hall of Aarhus, Jutland, and the programme is called Liegstouw, an ancient Danish form of folk dancing gathering which is revived for the occasion. Our Danish correspondent says that modern rhythm bands are nowhere in the picture when compared with such a show.

"THE BLUE DANUBE"

ON February 15th, 1867, in Diana's Room, Vienna, Johann Strauss' famous waltz, "The Beautiful Blue Danube," was played for the first time. On Sunday Vienna commemorates this great occasion by a Johann Strauss festival concert in the Musikvereinssaal, which will be broadcast by Vienna and many other European stations at 7. The conductors will include Johann Strauss (grandson), Weingartner, Grossman and Gruber. The Vienna Men's Chorus and the State Opera Chorus, together with the Vienna Symphony Orchestra, are taking part.

DIANA CHURCHILL with her husband, Vic Oliver, on their arrival in England. He appears in this week's Music Hall, together with the Western Brothers, Lily Morris and the Music Hall Boys.

HIGHLIGHTS OF THE WEEK

FRIDAY, FEBRUARY 12th.

Nat., 6.25, Northern Ireland Orchestra; Hamilton Harty programme. 8, The White Coons. 9.20, European Exchange—6, Denmark.
Reg., 6, "Intermission"; B.B.C. Variety Orchestra. 8.30, Sidonie Goossens (Harp) with the strings of the B.B.C. Orchestra.
Abroad.
Vienna, 7.50, Wagner Concert: the Vienna Symphony Orchestra.

SATURDAY, FEBRUARY 13th.

Nat., 2.35, Sporting Commentaries. 8, Music from the Movies. 9.20, Music Hall.
Reg., 6, The Band of H.M. Welsh Guards. 7.45 and 8.25, Act I of "Boris Godunov" from Sadler's Wells.
Abroad.
Hamburg, 7.10, A Radio Trip Round Hamburg's Pleasure Resorts.

SUNDAY, FEBRUARY 14th.

Nat., 5.35 "All for Love." 9.5, Hastings Municipal Orchestra.
Reg., 5.45, Concert by the Radio Budapest Salon Orchestra from Budapest. 7.5, "The Table Under the Tree."
Abroad.
Vienna, 7, Johann Strauss Festival Concert.

MONDAY, FEBRUARY 15th.

Nat., 7.20, The Music Shop—10. ¶ It's Happening Now. 8.30, Recital: Moiseiwitch.
Reg., 6.40, From the London Theatre. ¶ Star Gazing: Davy Burnaby. 9.20, Church, Community and State—6.
Abroad.
Nice (Côte d'Azur), 8.45, "Tristan and Isolde."

TUESDAY, FEBRUARY 16th.

Nat., 6.25, "The Nightingale"—Hans Andersen. ¶ Star Gazing: Davy Burnaby. 9.20, Church, Community and State—6.
Reg., 6, The Vagabond Lover. 7.30, Maidstone Choral Union. ¶ Organ Recital: Arnold Goldsborough. 9.30, Swing Music.
Abroad.
Paris (PTT) 8.30, Symphony Concert by the National Orchestra.

WEDNESDAY, FEBRUARY 17th.

Nat., 7, The Celebrity Trio. 8.15 and 9.25, Symphony Concert.
Reg., 8.15, Palace of Varieties. 9.30, Ice Hockey Commentary.
Abroad.
Brussels II, 8.45, Programme for the Anniversary of the death of Albert I, King of the Belgians.

THURSDAY, FEBRUARY 18th.

Nat., 8.10, Van Phillips and his two orchestras. ¶ Reginald Foort at the Theatre Organ.
Reg., 6, Alfredo Campoli and his orchestra. 7.30, Songs You Might Never Have Heard. 8.15, "The Nightingale."
Abroad.
Kalundborg, 7.10, Scandinavian Music by the Radio Symphony Orchestra.

A GUEST

THE Norwegian crooner, Jens Book Jensen, who appeared some time ago in one of Henry Hall's "Guest Hour" programmes, is now back in his home country after a Continental tour. He will be broadcasting on Thursday at

TAKEN IN 1867. A reproduction of a photograph of Johann Strauss, the waltz king, taken during the year in which the first performance of "The Beautiful Blue Danube" was given.

9.15 from Oslo with Skau's jazz quintet in a programme of popular English and Norwegian rhythm tunes.

"NUMBER MUSIC"

WITH the idea of showing Swedish listeners that highbrow music—Opus No. 2, Sixth Symphony, etc.—is not such a bore as many of them consider, the broadcasting organisation has prepared a programme, "Is Number Music a Bore?", which will be given to-night (Friday) at 7.

MISCELLANY

THE famous Don Cossack's Choir will broadcast from the Konserthuset Hall, Stockholm, over all Swedish stations on Saturday from 7 to 8.

Scandinavia's first tango band will make its broadcasting début from Oslo on Monday at 6.30.

"We discover America," a varied programme of original American compositions played by the combined station orchestras, comes from Berlin at 8 on Tuesday.

THE AUDITOR.

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More About Fading

By "CATHODE RAY"

Where AVC Cannot Help Matters

IN my last article I explained that fading is most often caused by a conflict between two or more sets of waves arriving at the receiver by different routes. There are other possible causes, such as variations in the effectiveness of a single line of communication (or silly things like a bad contact in the heater circuit of a valve, which may produce the same effect but should not be dignified with the term "fading"). For simplicity I am going to consider only the sort resulting from two sets of waves travelling over different paths. Similar principles hold when there are more than two.

It is quite clear that for two sets of waves to combine to cause a *complete* fade-out they must (1) be of the same length. Though it is possible for fading to be produced by waves from separate stations working on *exactly* the same wavelength, we shall consider waves from one station and which differ only in the direction in which they are radiated. As the wavelength does not alter on the way, it is bound to be the same at the receiver from whichever direction it is picked up. (2) They must also be of exactly opposite phase, so that when one is at maximum in a positive direction the other is at its maximum in a negative direction. (3) They must be exactly equal, otherwise even if directly in opposition there is a balance left over to constitute a signal. If (1) is not quite true, the result is a beat note or heterodyne whistle. That is ruled out of our consideration. If (2) and/or (3) are not quite true, the fade is not complete. In particular, if (2) is exactly reversed, the signal is stronger than that due to one set of waves only. The characteristic effect of fading as actually experienced is the constantly varying strength of the signal. Even without AVC, one wouldn't be inconvenienced so badly by a slightly weakened signal if it only remained *steadily* weak. *With* AVC one can put up with considerable variations so long as complete or nearly complete fades do not occur, and so long as distortion is absent. This distortion was hinted at last time, without any explanation as to how it might arise. The seriousness of it is that AVC is not only powerless to eliminate it but actually makes it very much worse unless rather special methods are adopted.

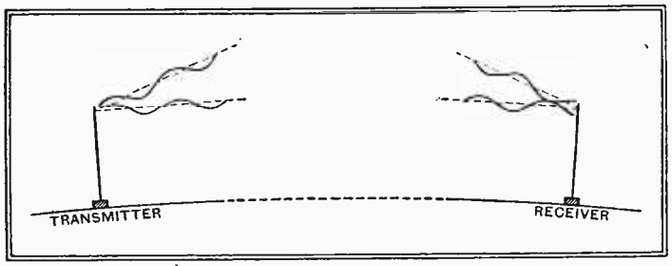

Fig. 1.—A transmitter is sending out identical waves in all directions; of these, two may find their way to a single receiving aerial, and it is a toss-up whether they arrive in such a way as to help one another or (as shown here) cancel one another out.

Both the variability of fading and the distortion are easier to understand if Requirement No. 2 above is worked out for a typical case. Suppose the broadcasting station works on exactly 30 metres, and therefore sends out a carrier of 10,000,000 waves per second. And suppose that the transmitter is 3,720 miles away, which works out at 6,000 kilometres. That is, let us say, the distance travelled by the more direct lot of waves. The distance travelled by the other lot might quite well be about 900 kilometres longer. It would therefore have 30,000 more waves on the way at any one instant than the shorter.

If there were *exactly* 30,000, the two lots would arrive exactly *in* phase and would combine to give a double-strength signal. But if the longer path were shortened by as little as 1 part in 46,000 there would be only 29,999½ waves difference, and the odd half-wave would be in direct opposition to that arriving by the shorter route, and, if equal in strength, would cancel it completely (Fig. 1). So it is easy to see that an almost infinitesimal change in the relative lengths of the wave paths—which, remember, are determined by something very closely akin to weather (an ominous thought where changeability is in question!)—is enough to cause the maximum possible degree of fading, and it does not need anything like rapid atmospheric changes to cause perhaps several complete fades per second. Fading is, in fact, liable to be both severe and rapid in short-wave long-distance reception.

Longer Waves: Slower Fading

Working the thing out for longer waves and shorter distances one finds that atmospheric changes of similar magnitude would give correspondingly slower fading; which entirely agrees with experience.

So far we have thought of the station sending out waves of one fixed length—the carrier wave. When it is modulated for broadcasting the effect is to produce "sidebands"—waves of slightly different frequency and, therefore, length. The lengths, strengths, and durations of these extra waves are continuously changing, so the whole thing becomes horribly complicated. But to give some idea of what happens, suppose our 30-metre transmitter is doing the simplest possible programme—the 1,000-cycle tuning note. This means that in addition to the 10,000,000-cycle carrier there are frequencies of 10,001,000 and 9,999,000 also. Along the short route there are lined up 200,000 complete waves belonging to the carrier, 200,020 belonging to one side band, and 199,980 belonging to the other. The longer route has room for 230,000, 230,023, and 229,977 respectively. Each of these three groups comes in exactly in step with the corresponding wave train by the short route—there are no fractional waves. Reception of the whole system is unimpaired. If, as supposed before, one of the routes alters so as to include half a wave more or less the carrier is wiped out at the receiving ends. The sidebands will also be shifted by half a wave + or − 1 part in 10,000. This slight inaccuracy can be neglected; to all intents the sidebands are wiped out, too. Everything is wiped out.

But now suppose the long route happens to include 235,000 carrier wavelengths. The same distance measures 235,023½ and 234,976½ sideband wavelengths. So although the carrier wave is received at maximum strength the sidebands cancel out, and it is as if modulation had ceased entirely! Even if the fading is only partial, AVC is worse than useless, for under the influence of the double-strength carrier wave it desensitises the receiver to an even greater than normal extent! Another half-wave shift, and the carrier wave has disappeared, but the sidebands have reappeared (as Alice would have said) like a grin without a cat. It is possible to transmit a programme in this fashion—in fact it is the approved method for long-distance radio telephony—but unless the carrier wave is artificially put back again by the receiver, there is very bad distortion. The ordinary broadcast receiver not only is unprovided with means for supplying the missing carrier, but the absence of carrier wave causes the AVC to release the full amplification, and the appalling distortion is passed through at overwhelming strength.

The foregoing does not claim to be a strictly accurate numerical account of

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More About Fading—

what happens, but it gives some idea of the sort of thing that is liable to happen though not often so badly. Naturally, when a full musical or speech programme is being transmitted the result may be very complicated; in addition to the form of distortion just mentioned there is fading which affects some sideband frequencies and not others, causing a general messing up of the whole thing. This selective fading (as it is called) is distinguishable when receiving most short-wave programmes—sometimes even within 100 miles range—and most often is noticeable as an alternating over-emphasis of bass and treble. Medium-wave and (rarely) even long-wave programmes suffer more usually from withdrawal of the carrier wave and a general cracking up and over-amplification of the sounds.

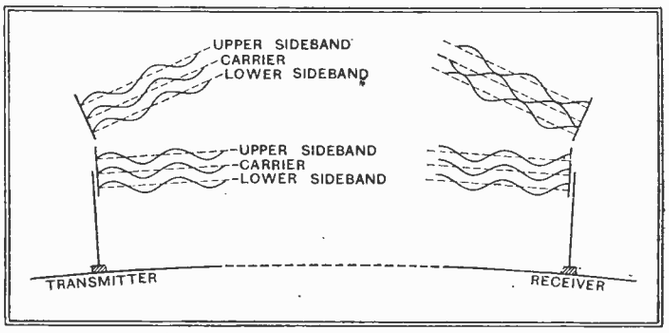

Fig. 2.—When even the simplest "programme"—a pure tuning note—is being radiated, there are three sets of waves of slightly different length. It is the differing lengths that make it possible for the sidebands to be reinforced and the carrier washed out (as here) or vice versa. The slight differences in wavelength between carrier and sidebands cannot be correctly indicated.

AVC, as I have shown, fails to cope with selective fading. The method used by the B.B.C. for long-distance relaying is to pick up the same programme on several aerials spaced apart at least a wavelength or two. The more aerials are used the less likely are all of them to be badly affected by fading at the same time. By combining the amplified outputs in such a way that the best of them cuts out the others and thus suppresses their distortion, it is possible to ensure a very much better standard than a single receiver could be expected to give.

Something can be done by aerial design. The "anti-fading" aerials much talked about for European broadcasting are transmitting aerials that radiate as much as possible at a low angle where it will serve its own area to a maximum distance without causing a disturbing reflected wave. It is possible to obtain some benefit in certain circumstances by using special receiving aerials, but unfortunately the matter is very complicated and not of general application.

The latest device—again, unfortunately of no use for broadcasting—may be described as diversity transmission. It is fully explained in two recent papers before the Institution of Electrical Engineers, and was worked out and tested in Australia by the authors of those papers. Very briefly, the idea is to modulate the carrier wave at a single frequency and then to suppress the carrier wave so that what is sent out is, in effect, two transmissions of slightly differing frequency. The frequency difference is calculated to fit in at least approximately with the difference in the length of the two paths taken by the waves in such a way that the combination never cancels out. It works according to plan, and as a demonstration is extremely interesting; but the conditions of success are so restrictive that it does not help you and me in a practical way.

Standard Frequency Transmissions

N.P.L. Monthly Tests

THE National Physical Laboratory, Teddington, Middlesex, undertake the transmission of two types of frequency of reference for standardising purposes. One is in the form of a modulation of 1,000 c/s and the other a radio frequency of 1,780 kc/s, approximately 169 metres. The last-mentioned is primarily intended for amateur experimenters.

The standard frequency of 1,000 c/s is radiated on a carrier wave of 396 kc/s, nominal frequency, 758 metres, on the second Tuesday in each month between 10.40 a.m. and 12 noon (G.M.T.). The announcement is made in Morse code, "CQ de G5HW standard frequency emission 1,000 cycles per second." After the preliminary announcement the standard modulation frequency is sent out for one hour continuously. The frequency is then changed by about −2.5 parts in a million to enable those receiving it to decide whether their own frequency of 1,000 c/s is above or below the Laboratory standard.

At the end of the transmission the exact frequency, correct to one part in 10 million, that has been transmitted will be given in Morse.

The standard radio frequency transmissions take place on the first Tuesday in March, June, September and December from 9 p.m. to 10 p.m. (G.M.T.). The preliminary announcement "CQ de G5HW standard frequency emission 1,780 kilocycles per second" is made in Morse which is then followed by a continuous dash, the whole lasting 15 mins. This procedure is repeated three times until 10 p.m.

No correction of frequency will be given, but the frequency transmitted will not be in error by more than one part in a million.

H. B. D.

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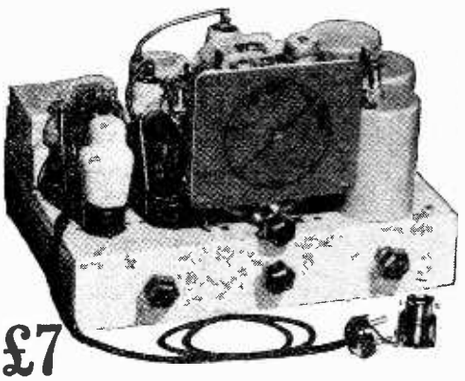

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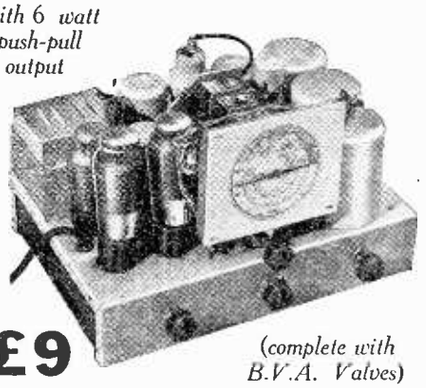

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By "DIALLIST"

Still Radiolympia

THERE were rumours a while since that the Wireless Exhibition would be held for the future not at Olympia but at Earl's Court. It won't. Those responsible for its organisation announce that they find the Olympia building the more suitable of the two. Furthermore, they have entered into a contract to lease it for the period of the exhibition for three years with the option of renewing for two more. So that's that. I confess I'm more than a little sorry to see that they have booked Olympia from the middle of August till the first Saturday in September for the three years "firm" as well as for the optional two years. This means that this year's exhibition may run from Wednesday, August 18th, to Saturday, the 28th, or from August 25th to September 5th, the latter being the more probable dates. In any event, we are committed to a summer Radio Show for the next five years.

Why Not a Technical Show?

For some years now the exhibition has tended to centre more and more about the entertainment side of broadcasting and to be of less and less interest to the technically minded visitor. Last year, of the 202,517 people who paid for admission, 68,862 went to the theatre, and doubtless came mainly with the idea of so doing. Another very large section went to Olympia chiefly because they wanted to capture their first television thrill.

I wish that we could have a good technical exhibition as well either in the spring or in the autumn. This year there's a fine opportunity for staging something that should make a wide appeal to enthusiasts. There's talk of a television exhibition; well, why not let it have an "advanced" wireless section. Most of the firms who will exhibit television gear are also makers of wireless sets, so there should be no great difficulty about it.

The Audience Problem

EVERY so often the question, "Should there be studio audiences for broadcast music-hall turns?" is raised once more. In their favour it is argued that very few entertainers can do themselves justice if they have to do their act "cold." I can quite appreciate that point, but there is another that I haven't seen brought out so far. It's this: the average user of a wireless set does his listening "cold." He's not a member of an audience; he's sitting, maybe alone, in an armchair by the fireside. Some entertainers grasp that very important point; others don't. To me it seems that the artist who requires to appeal to the mass hilarity of an audience in order to put his turn over may not always be ideal for the microphone. It's one thing to keep a crowd laughing and clapping once you've got them going, and quite another to amuse a little group of listeners round a distant loud speaker. I'm not satisfied, either, that playing to a studio audience doesn't tend to make an artist place too much reliance on gestures and facial expressions, forgetting that his bigger audience outside can see nothing of these. Of one thing I'm sure, and that's that the individual artist or the concert party with a turn that can be played "cold" and the ability to play it that way is far more likely to make a hit with listeners than those who must have an audience before them.

Battery Standardisation

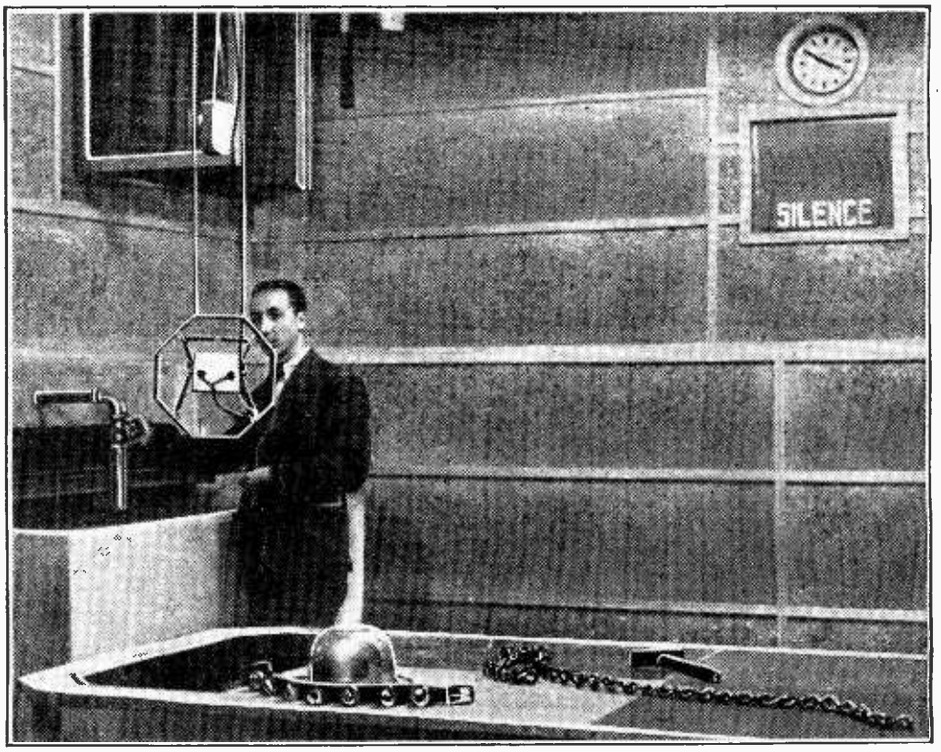
WITH no small rejoicing I read the announcement that the Radio Manufacturers are to discuss the question of standardising batteries in receiving sets. I only hope that in the next few weeks they'll do a good deal more than just discuss it. At present the situation, especially as regards dry HTB's, is ludicrous. About every other battery set on the market seems to need a high-tension battery of special type. Here there's a built-in grid bias section with several tappings; there special tappings are needed for screening grids or detector anodes. This set needs a battery of a size and shape that won't fit into that one. If only makers would standardise the 120-volt battery with just two sockets—positive and negative—for small sets, and the 150-volt with the same sockets for larger sets, everyone would be pleased. Automatic grid bias should be universal, and if intermediate positive voltages are required at various points they should be obtained by means of resistances. Standardisation is long overdue.

One Man's Meat

COULD a set be made, I was asked the other day, whose reproduction would satisfy everyone? I am pretty sure that it couldn't, for, no matter what measuring instruments may have to say about it, human ears don't agree at all on the subject of quality in electro-mechanical reproduction. To begin with, there is an enormous difference in the frequency response of ears. Some people cannot hear very high notes at all; others hear deep notes as mere noises and can hardly tell t'other from which when you play the five or six bottom notes on a full-compass piano. Then there's another complication. As we grow older we tend to hear high notes less and less strongly. High-frequency deafness or partial deafness is very common in elderly people. I wonder if you know why some of them cup a hand round one of their ears to catch what you are saying? Get a friend to speak without altering the pitch of his voice, move your hand to and then away from your ear and you'll soon see. When the hand is close round the ear, the high-frequencies are so much emphasised that his voice almost seems to rise in pitch. The less your normal high-frequency response the more marked will this effect be.

Tone Control Experiments

These things being as they are, it is not surprising that, quite apart from any question of one's being musical or non-musical, there should be such differences of opinion over what constitutes perfect reproduction—or, perhaps I should say, the nearest approach to perfection that our loud speakers can give. If you have a set with continuously variable tone control, try this on your



"NOISES OFF." The "effects" studio at Lausanne headquarters. The chains and water tank would rather suggest that the engineer is engaged in providing incidental noises for a blood-curdling "thriller."

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Random Radiations—

friends. Make a paper scale marked off into equal divisions from, say, 0 to 10, and place this behind the tone control knob. Now, ask friend after friend in turn to adjust the knob until in his or her opinion the quality is at its best. Keep a record of the scale readings of the adjustments and you'll have rather a surprise. Even those who have a reputation for being genuinely musical will be found to differ not a little from one another in their ideas of perfect balance between bass, treble and middle. I made such a record a while ago, and of some fifty people who were asked to turn the tone control knob till reproduction was most to their liking hardly any two produced exactly the same scale readings. The differences were so great as to be quite remarkable—all of which goes to show the difficulties that face the manufacturer of wireless sets.

Appreciation of Quality

WHILST talking the other day with the head of a fairly important radio manufacturing firm, I learnt that he had been pleasantly surprised by the big demand for console sets. His company had hoped to market a considerable number of these during the year, and had made up what they thought would be sufficient to meet the demand; but they were clean sold out some time before Christmas. He asked me if I could explain this run on consoles, though they are so much dearer than table models —in this particular case the difference is a matter of £6 odd. My reply was that appreciation of good quality in reproduction is growing, and that those who want the best are quite prepared to pay for it. There's no question that a well-designed console, with a big heavy loud speaker and a cabinet as nearly free as may be from resonances, is much to be preferred to a small table set. The fact that the public has shown that it doesn't mind paying a good bit more for the console goes to prove what I have long maintained: offer first-rate sets and they'll sell even if the price is pretty high.

Our Indian Trade

RECENTLY published figures for radio imports into India do not make overgood reading. For 1935-36 the total of such imports had a value of £212,250 in round figures. Of this £78,600 worth came from Great Britain, £28,000 worth from Holland and £85,700 from the United States. Now the British figure must be made up very largely of the money paid for transmitting equipment for broadcasting stations, aerodromes, and so on, and for commercial receiving gear. It follows that the greater part of the trade in domestic receiving sets has been collared by America and Holland. It does seem a thousand pities that our manufacturers neglect that very promising market (the U.S.A. figures grew from £13,500 in 1933-34 to £62,000 in 1934-35, and will no doubt be over £100,000 for 1936-37) by not making the kind of sets that are wanted. The three-valve-plus-rectifier superhet is no good there. Both the British stationed in the country and the wealthier Indians want big, sensitive sets that will stand up to the climate—and they are quite ready to pay well for them.

DISTANT RECEPTION NOTES

POOR Parede; it does seem to have a thin time! Not so long ago it was very badly damaged by fire, and now it is reported to be out of action for the time being as the result of a bomb explosion. The aerial of the Emissora Nacional (Lisbon, 476.9 metres) is also stated to have suffered considerably in the same way. Except on the short waves, Portugal is one of the very few European countries whose programmes are seldom heard here. Parede shares the 291-metre wavelength with Köenigsberg, whose 100 kilowatts give little chance to its five. The Emissora Nacional, of 15 kilowatts, has the 20-kilowatt Trondelag as a channel partner and is to be heard only when the Norwegian is not at work.

At the moment of writing there are no less than fourteen large spots to be seen on the sun's disc, and the Astronomer Royal has stated that they cover an area eighteen times as big as the whole surface of this world of ours. They will have disappeared temporarily by the time that these notes are in print owing to the sun's rotation, but it won't be long before they are back again. It seems as if the coming sunspot maximum is likely to be marked by particularly big outbreaks of activity. Already we have had some of the largest spots seen for many years, and the present crop of fourteen is a pretty fair collection!

If the spottiness is maintained during the summer we can look for plenty of atmospherics when we try for weak and distant stations. In the reception of the nearer and larger stations atmospherics are nothing like the bugbear that they were a few years ago. Thanks to high-powered transmitters, the signal-to-noise ratio is usually good enough for satisfactory reception unless atmospherics become very violent.

A heartening thought for long-distance men is that what we lose on the swings of the long waves and the medium waves we gain on the short-wave roundabouts during periods of solar activity. As transmissions on the longer waves become less and less reliable those on certain short-wave bands grow better and better.

Has anyone yet succeeded in logging Jerusalem? It's not an easy feat, since it works on the same wavelength as the North Regional. But it is a 20-kilowatt station and it should be receivable if one could only find it at work at some time when the North Regional wasn't. Unfortunately, Palestine time is two hours ahead of ours, so that Jerusalem closes down for the night long before the North Regional. The most promising time for hunting the station seems to be after midnight on weekdays, in the hope that a test may be in progress after normal hours.

A list recently published by the American *Radio News* of European stations best heard in the United States is not very flattering to our national pride. Only five British stations appear—the London, North, West, Scottish and Northern Ireland Regionals. But there are six Germans (Stuttgart, Cologne, Leipzig, Hamburg, Frankfort and Nüremburg) and no fewer than fourteen French stations.

D. EXER.

A COMPLETE CONDENSER SERVICE

T.C.C.'s interpretation of service is not just making those condensers which the modern receiver demands, but also *anticipating to-morrow's problems.* These dry electrolytics, for instance, more or less standard now, came into being in the T.C.C. laboratories *before* any demand for them existed. They were designed ready for the set-maker's NEXT job! T.C.C. is always a step ahead Television is beginning to settle down—but all the necessary condensers are all ready—already!

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ARE DOUBLE SEALED (apart from the container seal) to resist humidity.

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Letters to the Editor

The Editor does not hold himself responsible for the opinions of his correspondents

Interaction of Radio Waves

From Professor V. A. Bailey, University of Sydney

I SHOULD be glad if you would draw the attention of your readers to the importance of making systematic observations of the interaction of radio waves in order to obtain information about the interaction *caused* by stations in the short-wave end of the broadcasting band. Nearly all the reports previously published were about interaction backgrounds caused by stations with wavelengths exceeding 400 metres. There are reasons for believing that observations of backgrounds caused by waves of lengths between 400 metres and 100 metres would considerably assist in unravelling the nature of the ionosphere. It is therefore a matter of the greatest interest to obtain as many regular reports of such observations as possible.

The success attained by the systematic observational work of the World Radio Research League in the early days of radio interaction is an encouraging indication of what an organised effort by amateurs may achieve.

I have just recently arrived from Australia and will be in England during the next nine weeks. If during this time a concentrated effort is made, by as many of your readers as can do so, to send me regular reports of systematic observations I would be able without delay to analyse them in the light of the theoretical work on the subject. The matter is urgent, and so to save time and trouble I have prepared a sample form with a suggested code which your readers might copy and use in submitting all their reports.*

In carrying out this work the following points should be attended to:

1. The observations should be made at the same time or times at night.

2. Some regular observations should be made as late at night as possible.

3. Backgrounds on Morse transmissions should also be investigated.

4. Note should be taken of the relative strengths and fadings of
   (a) The wanted station.
   (b) The background.
   (c) The direct reception of the station which causes the background.

5. Backgrounds caused by stations of wavelengths exceeding 400 metres should be avoided wherever possible.

6. *It is absolutely necessary that the identity of the station causing the background should be clearly and unambiguously established.*

Where several stations are simultaneously radiating the same programmes on different waves the problem of identification may be difficult. But where *all* the stations in such a group have the same wavelength, such as, for example, Cassell, Coblenz, Frankfurt, Freiburg-in-Breisgau and Trier, the identification of the group is as valuable as that of a single station. A group like Frankfurt and Stuttgart, or like Athlone and Dublin, yields far less valuable information.

Subject to your approval I would suggest that all such reports be addressed to me c/o the Editor of *The Wireless World*.

V. A. BAILEY.

*This form, which can be cut out for use, will be found on page 10 of the advertisement section.—ED.

Holland's Broadcasting House

IN the January 22nd number of *The Wireless World* we saw the article on our new A.V.R.O. studio building.

We were very much interested in this article, which is illustrated with really good photos.

As to the article itself we would like to draw your attention to the fact that on page 80, in the centre column, the author writes that "Most of the control equipment was supplied from Germany."

This, however, is not quite correct. The whole equipment of both control rooms was made by the Dutch firm Philips. Only the apparatus in the sound recording-room is of German construction. The receivers in use in these control rooms were also supplied by Philips.

ALGEMENE VERENIGING
"RADIO OMROEP."
Hilversum, Holland.

Super-regenerative Receivers

I HAVE read with interest the letter by Mr. M. G. Scroggie in your issue of January 22nd concerning my article on improvements to the super-regenerative receiver, and I would like to clear up the points he raises. I have not yet seen his article in *The Wireless Engineer*, but I shall take the first opportunity of reading this, and am interested to note that he has been writing on somewhat similar lines. It is not difficult to see that any alteration to the quenching waveform that will result in an increased proportion of regenerative to quenching time period, must tend to improve selectivity as well as sensitivity. Presumably the selectivity of this circuit is due to the regenerative action, and is likely to be increased by any change which intensifies this action. I am, of course, aware of the influence of actual quenching frequency upon selectivity, but in my experimental work did not observe any marked effect of waveform upon this factor. At the time I was not looking for this effect, and was not using any exact method for the measurement of selectivity. I am sure Mr. Scroggie will agree that selectivity remains the main problem, and anything which will lead to improvement in that respect should be further investigated. My article was written, as it happens, many months ago, since when my work on the circuit has made good progress, and I hope to be able to amplify my remarks in a future article.

Taking Mr. Scroggie's last point first, and in relation to Fig. 1 particularly, the change from positive to negative quenching is obtained according to the position of the resistance R across which the quenching potentials are tapped off to the detector. If this be in the anode circuit, as in Fig. 1, the peaks of quenching oscillation will result in negative maxima of the detector grid potential; whilst if R be moved to the cathode circuit, as is intended in Fig. 3, the reverse condition will occur, quenching being positive. It was not intended to suggest that this change could be made during operation. It is quite incidental to the main issue of waveform.

I regret that space did not permit of any full discussion of the various multiple valve types which might be pressed into use for circuit 3. Their action, of course, differs considerably. As I think would any engineer, I prefer circuit "1" whenever possible, as the use of two separate valves assists performance and adjustment in many ways. However, thinking that many experimenters would not like the additional valve and increased heater consumption, I provided the circuit of Fig. 3 also. Practically, I have even used an FC4 Octode here with success. The operation is obviously far from that described, but the resulting waveform differs very little from that given by Fig. 1. I would not claim that the use of the multiple valve is preferable, but it may often be more practicable.

In conclusion, I must apologise for a small error which has crept into the circuit of Fig. 3, and which Mr. Scroggie has unerringly placed his finger upon! The control grid leak of the triode-pentode should, of course, be returned to the earth line, and not to cathode, as shown. As cathode biasing by means of the resistance R is specified in the text, however, I think the majority of readers will have appreciated what was intended.

E. L. GARDINER.
Northwood, Middx.

Defining Interference

I WAS very interested to read your editorial comment on the British Standard Glossary; I too had searched it to see if "interference" classification had been simplified in any way.

In your issue of January 19th, 1934, I argued that we might clear up the difficulty by dropping the word "interference," since it had become ambiguous, and use the words "heterodyne," "disturbance" and "atmospherics" to differentiate our three external noises. During 1933 I had made this suggestion to the I.E.E., but they considered that the word "interference" was already too firmly associated with machine-made noises and should not be changed.

Since then for three years most of us have had to use two words instead of one to be on the safe side, and talk of "station interference," "electrical interference" and "atmospheric interference." During this period the word "interference" by itself has, with I.E.E. and B.S.I. backing, become more firmly associated with electrical machines, and the word "heterodyne" seems to have fallen out of use for describing station overlap, and is not understood by the general public.

I think we can therefore agree that there are no obstacles in the way of agreeing to your suggestions of "interference" for machine-made noises only and "atmospherics" for the efforts of Nature, and the way seems clear to choose the most suitable word for signal interference. "Jamming" was the first word widely used for this, and I cannot foresee any confusion by its adoption. To resurrect "heterodyning" would in these days confuse the public, as they are used to seeing (but not understanding) the word "superheterodyne," and they might think the latter indicated a cure for the former.

Having argued the matter out in this way, I am entirely in agreement with your suggestions, and if they meet with general

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approval my company will be only too pleased to put them into use immediately in all our publications. E. M. LEE,
Enfield. Belling and Lee, Ltd.

Service

MY attention was drawn to-day to two paragraphs in *The Wireless World* dated December 25th, under "Random Radiations," by "Diallist," sub-heading "Some Service."

These paragraphs report that an American contemporary, *Radio News*, in an investigation of shady service work in New York, actually had a straightforward receiver in first-class order placed in the home of a private person and one wire disconnected in the output circuit, after which various service men were asked to repair the receiver, a record being taken of what they diagnosed, what they charged, what they did and did not supply, and it revealed some most unpleasant facts.

That is business. Business of the type that goes on all over the world in every trade and profession, and although I am a manufacturer's service manager I feel that I must take up the cudgels this time on behalf of the dealer, whether he is or is not efficient in his work.

The principal reason for the public being "twisted" (I must use this word) is because the public will try to twist anybody in exactly the same way if it gets the chance.

If a competent service man who is perfectly honest and does not allow himself to be influenced by the morals of the business world, which for most of us lies between 9 o'clock on a Monday morning and 12.30 on a Saturday, visits the owner of such a set, what would happen?

Taking his meters into the house, he would run over the receiver and find the fault.

He would reconnect the wire, tune in several stations, and when satisfied with his work he would pack up his gear. He would calculate the time he has been there, total his distance from the shop or factory, and his own time, probably a little over in order to keep his wife and family, and then tell the man that it will cost him, say, 15s.

The reply would be "Whaaat?" Then the owner will go on to say that the service man hasn't supplied anything, it was only a broken wire. "Why should it be 15s. for a broken wire?" The public cannot see what lies behind that service of the honest man.

The way to combat it is the way adopted by those who are not so honest, and *they* say that they had to put in certain condensers, valves and other things.

I cannot see how you are going to get over this practice until the public learns to pay for skill, time and expenses.

In my department at the works sometimes one of my engineers or mechanics may spend an hour and a half tracking down an obscure fault and localising it in a fixed condenser (intermittent dis. internally), and the owner expects to pay only sixpence for the condenser.

To round off this letter I should like to tell you a little story, and since I am rather ashamed of it now, having become an honest man, I refrain from signing this letter, although I give you my name and address separately.

When I first went to live in a certain district I was introduced here and there to new friends, and in the course of conversation one by one they found that I was connected with a certain wireless firm. Every now and then there was a knock at the front door, or the bell would ring in the evening, and there would be one of my new friends with the usual, "I say, old man, my set's gone wrong. Will you, please, come round and fix it?"

I would put on my shoes and go round putting wireless receivers right because they were owned by my friends.

One particular evening when I had some work to do, and I was safely indoors with my slippers on, there was another knock at the door, and the same thing happened. On this occasion it was a man who could well afford to buy several wireless receivers and not run the funny old thing that he did.

He asked me the same question.

Without moving a muscle, I looked straight into his face and said: "That will cost you . . . ," and I named a figure which could only justifiably be charged by a Harley Street specialist on the first visit of a patient.

For a moment he stood there undecided, but being a big man, and knowing he was a big man, and not liking to be considered small, he said: "All right."

I went along to his house, connected up the two wires that were disconnected, and he sat down and wrote out the cheque.

Since then I have adopted the procedure of professional men. If anyone should start talking about his wireless receiver to me I just Hm! and Ha! and say "Yes" and "No" and "Maybe," or "I shouldn't be at all surprised."

And then, if they keep on long enough, I say: "I say, old man, are you asking my professional advice about this? Would you like me to come round and have a look at your set?"

I find that in about 50 per cent. of cases they hasten to say: "Oh, No! No! No! I was just enquiring, that's all," whereas in 50 per cent. of cases they are willing to pay, and I make it quite clear that I'm going to charge for my services before going round. ALTER EGO.

Two-stroke Motor Cycles. Sixth edition. Pp. 134, 72 diagrams and illustrations. Published by Iliffe and Sons Ltd., Dorset House, Stamford Street, London, S.E.1. Price 2s.

THE fact that yet another edition of this book has had to be produced gives an indication of its well-deserved popularity. The book aims at telling the novice all that he should know about two-strokes, but at the same time experienced two-stroke enthusiasts will find many valuable hints and tips within its covers. N. P. V.-M.

The British Journal Photographic Almanac, 1937. Pp. 716; 64 photogravure plates. Numerous diagrams and illustrations. Published by Henry Greenwood and Co., Ltd., 24, Wellington Street, Strand, London, W.C.2. Price 2s.

THIS well-known annual has once more made its appearance. It contains a large number of formulæ and other tabulated data, together with a considerable amount of useful commercial information. In addition, there is a wealth of technical articles dealing with all aspects of photography and cine-photography and a considerable number of well-chosen photogravure reproductions of outstanding studies of the year. N. P. V.-M.

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Recent Inventions

The British abstracts published here are prepared with the permission of the Controller of H.M. Stationery Office, from Specifications obtainable at the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1/- each. A selection of patents issued in U.S.A. is also included.

Brief descriptions of the more interesting radio devices and improvements issued as patents will be included in this section.

PREPARING PHOTO-SENSITIVE ELECTRODES

A KNOWN type of photo-sensitive surface consists of oxidised caesium on a backing-plate of silver. In the ordinary way the necessary oxidising is effected by means of a glow discharge produced between the photo-sensitive surface and a second electrode. But in the so-called mosaic-cell type of electrode, as used in the Iconoscope transmitter, this procedure is not possible, since the small cells are insulated from each other and from the metal backing-plate.

According to the invention the difficulty is overcome by introducing into the cathode-ray tube an auxiliary loop of wire forming a "ring" electrode, which is temporarily placed in position between the cathode of the tube and the mosaic-cell electrode. The ring of wire is first given a high positive voltage, so that the stream emitted from the cathode is projected through it at high speed against the mosaic cells, and so oxidises them. When the oxidisation is complete, a heavy current is passed to fuse a thin wire holding the auxiliary ring in place. The latter then falls away to the back of the mosaic-cell electrode, having served its useful purpose.

W. Heimann. Convention date (Germany) May 20th, 1935. No. 455899.

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TELEVISION AND BROADCAST RECEIVERS

A SET is designed so that it can be used either to receive programmes broadcast on the ordinary wavelengths, or combined sound and television signals on 6-7 metres. The figure shows a superhet. receiver fitted with a short-wave frequency-changer FC, so that the circuits normally used for tuning to the broadcast programmes serve as an intermediate-frequency stage when receiving television signals. Switches S, S1 simultaneously insert damping resistances R, R1 in order to broaden the frequency band to the extent required to cover the television frequencies, whilst a further damping resistance R2 serves the same purpose in the original IF stage. The switches may be ganged to the tuning control in such a way as to be operated automatically when the latter reaches its minimum position.

Marconi's Wireless Telegraph Co., Ltd., and A. Linsell. Application date April 26th, 1935. No. 455649.

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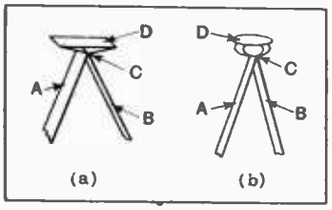
EQUI-POTENTIAL CATHODES

A CATHODE which is, in effect, indirectly heated is made by spot-welding together the two limbs A, B of a hairpin filament at a point C near the top, leaving a short-circuited loop, as shown in the figure (a). Or the top portion D may be trimmed off into a flat disc as shown in the figure (b).

The heating current supplied to the limbs is, of course, short-circuited at the point C, so that the loop or disc D, which is coated with an emissive substance, is heated solely by convection. Since this part carries no current,



Method of constructing equi-potential valve cathodes.

it is free from any external magnetic field. Moreover, the electrode is easily made and mechanically strong.

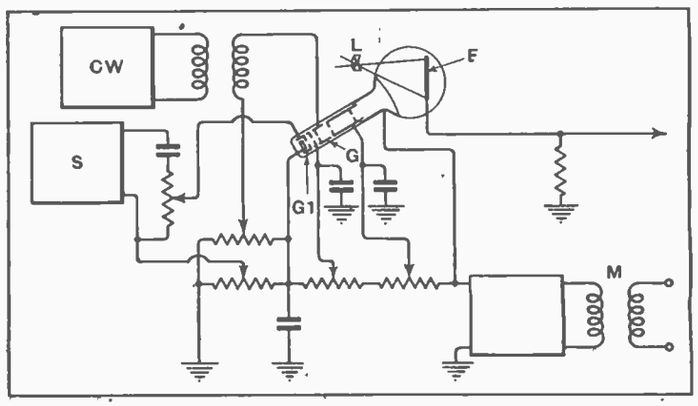
Ferranti, Ltd., and M. K. Taylor. Application date April 16th, 1935. No. 455351.

o o o o

TELEVISION TRANSMITTERS

THE picture to be transmitted is focused through a lens L on to a photo-sensitive electrode E of the mosaic-cell type, where it is scanned by the electron stream from the cathode of the tube. Carrier-wave frequencies are applied from a source CW to one electrode G, and synchronising impulses are simultaneously supplied to a second electrode G1 from the source S. Or, instead of the synchronising impulses, a voltage may be applied to G1 which corresponds to the average or back-ground brightness of the picture. In this way the electron stream used for scanning the picture electrode E is subject to a double modulation. Operating voltages are supplied from the mains at M.

J. E. Keyston and L. F. Broadway. Application date April 17th, 1935. No. 455555.



Modulating system for television transmitter using cathode-ray tube.

"PROSPECTING" BY RADIO

ONE known method of locating a hidden conductor, such as a buried mass of metal ore—or the presence of a ship in fog—is to explore the suspected area with a directed beam of wireless waves, which are reflected back by the conducting body, and so will give an indication of its presence. This method, however, requires the use of a transmitter placed at one point and a receiver located some distance away to pick up the reflected waves.

According to the invention both the transmitter and receiver are mounted one above the other on the same shaft, and the beam from the transmitter is so directed that, as it is swept from one end to the other of the area to be prospected, any reflected beam is returned, along a line in the same vertical plane, direct to the receiver. The rotating shaft carrying the two instruments is automatically arrested by any received signal, so that it remains pointing in the direction of the reflecting body.

Compagnie Générale de Télégraphie sans fil. Convention date (France) April 20th, 1935. No. 455765.

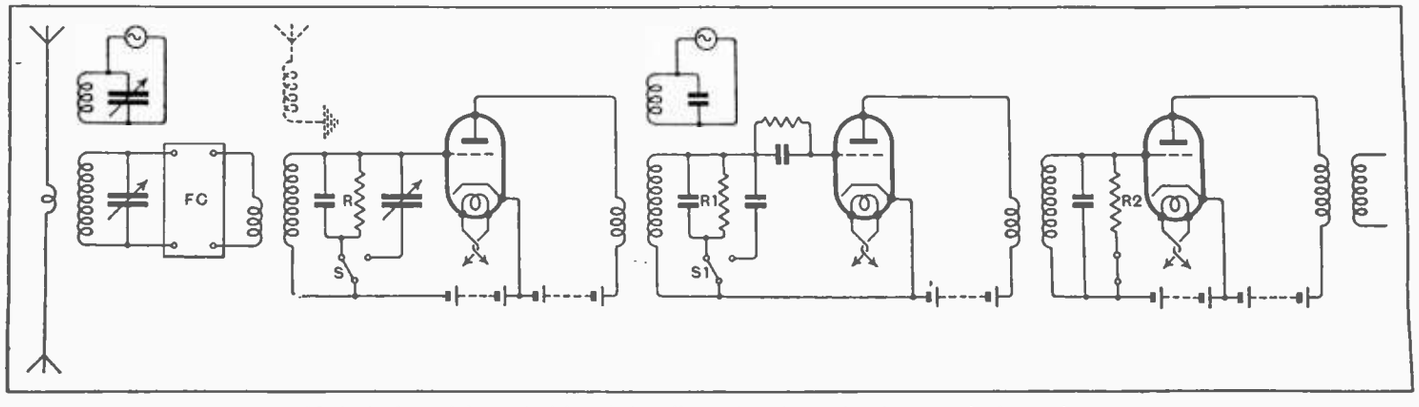
o o o o

DELAYED AVC

ONE method of delaying the action of automatic volume control is to apply an initial negative bias to the anode of the diode valve in which the AVC voltage is developed. This introduces a "threshold" point below which weak signals are automatically shut out from the set.

According to the invention, a similar "delay" action is secured by the use of a biasing voltage on the screen grid of a tetrode valve. The normal AVC voltage is applied to the control grid of that valve, but the screen-grid voltage causes the upper part of the grid-volt plate-current curve to be flattened out, so that the voltage-drop across a resistance in the output circuit remains practically unaltered up to the threshold point.

Standard Telephones & Cables, Ltd. (Assignees of Standard Villamossagi Reszvenytarsasag). Convention date (Hungary) September 3rd, 1934. No. 455665.



Method of receiving television and ordinary broadcast signals on a single receiver.

www.americanradiohistory.com

Wide Frequency Response

To obtain satisfactory Bass response from a Moving Coil Loudspeaker of the baffle type, it is necessary to use a comparatively large Diaphragm. This ensures sufficient air loading to prevent excessive movement of the Voice Coil. The diaphragm must also be reasonably rigid to prevent undue break-up. This necessitates the use of fairly dense material having appreciable weight. Such a diaphragm is, unfortunately, quite unsuitable for reproducing frequencies above about 4,000 cps.

Although the low impedance Voice Coil of the average 10in. or 12in. Loudspeaker is capable of responding to current variations up to 10,000 cps. or 12,000 cps., provided care is taken to ensure that the coil former is light and rigid, the high note radiation is negligible, due to the inability of the large diaphragm to move at these frequencies. Normally, a slight flexing takes place near the junction of the cone and coil. However, by attaching a small very light and rigid cone direct to the coil, extremely faithful reproduction of these high frequencies is obtained. Due to its extreme lightness, and heavy damping by the main diaphragm, this additional cone is able to respond to almost instantaneous variations of signal current, such as occurs during the transmission of transients. This makes for good *attack* and crispness so essential for "high fidelity" reproduction.

The *exclusive* design of "Twin Diaphragm" construction used by GOODMANS for their 12in. and 10in. High Fidelity Auditorium Loudspeakers, is fully covered by Letters Patent, and should not be confused with any other "Twin Diaphragm" construction (Also licensed under Voigt's Patent).

N.B.—Other highly interesting technical data on Loudspeaker Construction is published in a Bulletin issued with Response Curves (see Coupon).

DEMONSTRATIONS of Goodmans Loudspeakers held every Thursday Evening at the Wembley Works between 6 p.m. & 7 p.m. (5 mins. from Wembley L.M.S. & Bakerloo Stn., & Buses & Trams)

Other demonstrations by special appointment—
Telephones: Wembley 4001-4003.

GOODMANS 12" High Fidelity Auditorium Reproducer.

Price, without Transformer, **£8.3.0.**

Also 10" Model, complete with Transformer, **£3.10.0.**

GOODMANS

for Quality Reproduction

POST this COUPON to

GOODMANS INDUSTRIES LTD., LANCELOT RD., WEMBLEY, MIDDX.

Please send me Technical Bulletin with response curves describing GOODMANS High Fidelity Auditorium Speakers, for which I enclose 3d. in stamps.

Name.....

Address.....

.....

W.W. 12/2/37.

For really high-grade mains transformers and chokes—it's best to go to Savage!

★From our standard lists or to your specifications. We will gladly send you lists on request or quote to your particular requirements.

W. BRYAN SAVAGE LTD.

WESTMORELAND ROAD, LONDON, N.W.9
PHONE: COLINDALE 7131 (3 LINES)

RECORD

The quality valve in the COMPLETE range

RECORD RADIO LTD., 2/3, Eldon Street, E.C.2

Reliability

If your set needs the assistance of an expert service engineer, be sure to enlist the aid of one who can "get down to brass tacks" and give you prompt service at a reasonable cost. Identify him by the gold "AVO" Service Sign. It means that he is equipped with the best and most accurate instruments for efficient and speedy servicing.

Literature describing any of the AVO Testing Instruments free on request to

AUTOMATIC COIL WINDER & ELECTRICAL EQUIPMENT CO., LTD., Winder House, Douglas St., London, S.W.1

Telephone: Victoria 3404-7

ELECTRADIX BARGAINS

MOTORS ! MOTORS !
Tiny, Small and Medium horse-power. A large stock of really high-grade Motors and Convertors have been released at bargain prices. 300 at 21/8 for immediate delivery.
A.C. MAINS MOTORS.—Enclosed, self-start on load. A.C. repulsion, 1/60 h.p. with pulley, Type 40, 1,500 revs., 18/6. Type 36, ditto, 1/25 h.p., G.E.C., 3,500 revs., 27/6. Induction 1/10 h.p., 2,500 revs., 35/-. ¼ h.p., self-starting, 1,425 revs., 49/-.
D.C. MAINS MOTORS.—1/40 h.p., Type 60, 220 v., K.B. series, 1,750 revs., 15/-. Ditto, 1/40 h.p., G.E.C., 230 v. series, 2,000 revs., 16/-. Ditto, 1/12 h.p., Croydon 110 and 230 v. shunt, 1,700 revs., 30/-. M.G. for A.C., 220 v. to 100 v. 1 amp. D.C., 60/-. 100 v., 15/-. All fully guaranteed.
DOUBLE CURRENT DYNAMOS.—D.C. 600 volts 100 m.a., 32/6.
ROTARY CONVERTORS for A.C. sets on D.C. mains. 7-watt P.M. model, 35/- ; 15-watt 220 D.C./220 A.C., ball bearings, lam. field, silent running, 65/-.
M.G. Sets with filter, 6 v. to 170 v. 25 m.a., for H.T., 65/-. Dynam and Switchboard, 12 v. 12 amps., 47/6.

67/6

PUMPS AND COMPRESSORS, ETC.
Coronation Fountain Electric Pumps, for A.C. or D.C. mains. Centrifugal, all-bronze pump, 3 ft. lift, 120 gals. per hour. For 6 ft. fountain, etc. Wiht 50 yds. twin rubber cable and iron-clad D.P. switch, 67/6. Larger pumps quoted for.
AIR COMPRESSORS for Paint Spraying, Set Cleaning, Inflation, etc Foot Operated, 37/6. Electric No. 1 size, £5/15/-. No. 2 Twin-cyl., £7/10/- A few S.H. Plants in good order, cheap.
MOTOR BLOWERS or Exhausters. Strong iron body, 3 in. fan outlet, direct coupled to motor. A.C. 220 v., 65/- ; D.C. 110 v., 45/- ; D.C. 220 v., 55/-. For air conditioning.
A BARGAIN IN DYNAMOS. Type "C." Our latest for Bungalow, Yacht or Cell Charging. 140 watt. Enclosed Dynamo, 12-20 v. 12 amps. Ball Bearings, Vee Pulley, 25/-.
Marine Type Switchboard with Ammeter, maximum and minimum Auto Cutout Mains Switch and Fuses, Field Regulator, 25/-.

BATTERY CHARGERS AND A.C. RECTIFIERS.

Sold all the 4-circuit DAVENSET Chargers as illustrated but have an A.C. to D.C. 3-circuit 28 guinea Davenset Charger which will charge 120 L.T. cells and a batch of H.T. as D.C. volts are 150 v. New model, H.T.3, fitted Ferranti meters, 3 current regulators, 4 switches and an automatic overload trip. As new, £12/10/-. Another Davenset, also new, Type S.P.C.L., with an output of 250 volts 250 m.a., also fitted Ferranti meter and wide range volt regulator. Sale, £7/10/-. A 3-phase Devenset, converting 1½ kW. 400 v./460 v. to 220 v. 6 amps. D.C. This has 3-pole auto circuit-breaker and Philips valve. Sale, £9/10/-. Several Tungars and Westinghouse, cheap. A.C. to D.C. Motor Chargers, all sizes in stock.
CORONATION ARC LAMP AND FLOOD LIGHTS, Cable Resistances, etc. Porcelain Cleats, 6d. pair. ELECTRIC LIGHT, 1,000 Porcelain Ceiling Roses with Ramie Junction Connectors, 5/- doz.
DYNAMOS, MOTORS, ALTERNATORS AND ROTARIES, Big stock P.A. Sets, Amplifier Microphones and Speakers for outdoor use, 5 watts to 20 watts, at tempting prices.

Send for Electrical and Radio Lists "W."

ELECTRADIX RADIOS

218, UPPER THAMES STREET, LONDON, E.C.4

Telephone: Central 4611

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The proprietors are not responsible for clerical or printers' errors, although every care is taken to avoid mistakes.

NEW RECEIVERS AND AMPLIFIERS

A.

A.

DEGALLIER'S, Ltd., the best firm for reliable fully guaranteed ultra short-wave radio, have on view in London without exception the largest selection of all-wave receivers, at very low prices. For instance, a 7-valve superhet., with 3 bands going down to 16 M. in A.C. or A.C./D.C., at £9. An 8-valve superhet., 4 bands going down to 11 metres, with push-pull output 7 watts undistorted, is only 13 guineas. Any known American valve for receivers 1925-1937, glass, glass counterparts, metal, and M.G. at 6/6 each, all firsts. They have range like this right up to a 24-valve Challenger twin-chassis, valves and two Auditorium speakers, 5-bands 5-2,050 metres, 60 watts undistorted at £50 (this is as supplied to the Navy, Army and Air Force canteens). They guarantee that every S.W. receiver will get stations on the low bands including the Americas, etc. Why not call and handle these receivers at your leisure? Demonstrations daily from 3.30 onwards on American transmissions. No obligation to purchase. Or send large S.A.E. for beautifully illustrated catalogues with actual photographs. Also in stock, Ferguson, Emerson, Belmont, Crosley, Garod, etc.

DEGALLIER'S, Ltd., No. 18, Connaught St., Marble Arch, W.2. Paddington 2745. [3803

ROYAL RADIO Co.

ESTABLISHED 1908.

ALL-WAVE Receivers, suitable for use on ships, as supplied to officers of many shipping lines.

OUR 8 and 10 Metal Valve All-wave Receivers; 15-2,000 metres, acknowledged by the trade as the best for range, tone, and generous performance.

LATEST 6-valve Car Radio, A.V.C., remote control, no suppressors required.

A FULL Range of the World Famous Ferguson and Pilot Models Stocked.

ALL Sets Fully Guaranteed by Ourselves.

ALL Types of American Valves Stocked.

ANY Make of Set Serviced by Our Qualified Radio Engineers at Reasonable Charges.

PAY Us a Visit Any Time, or send for full range catalogue; 1½d. stamp will be appreciated.

ROYAL RADIO Co., 5, Buckingham Rd., South Woodford, London, E.18. 'Phone: Buckhurst 2736. [3810

ALERT RADIO Co.

COMMUNICATION Receivers, all-wave chassis, complete receivers of all types, American valves, spares and service; we also have a few reconditioned receivers.—21, East Rd., N.1. Clerkenwell 4871. [3787

TRANS-ATLANTIC RADIO'S Wonderful All-wave Offer.—10-valve American A.C. chassis, 100-250 volts, 5 wavebands (covering all wavebands), push-pull output 10 watts, 12in. Magnavox Auditorium speaker, £12, carriage 6/-; only few left; Compacts from 59/6.—Trans-Atlantic Radio Co., 15, Percy St., W.1. Museum 3096. [3804

HT

DUODE DE LUXE

Our readers may remember that last autumn we made a preliminary announcement of both the "Duode" and the "Duode de luxe" speakers. The latter had a moulded exponential diaphragm, and gave a superior performance.

After the first announcement, further research was done on this speaker, and in the course of it we discovered that the improved performance was not, as we had supposed, due to the effect of the special cone *as a diaphragm*, but to the fact that its shape enabled us to make a stronger joint to the central tube, with the materials and methods then available.

We therefore began a further research on methods of making this joint, with the result that we can now make (with our standard straight cone)

A BETTER SPEAKER THAN THE DE LUXE OF LAST AUTUMN

As the only difference in structure between Duode and Duode de luxe is now that the latter has a superior cone-to-tube joint, we have decided to withdraw the less efficient type.

The Hartley-Turner speakers now available are therefore—

1. Permanent magnet standard	£5 0 0
2. Permanent magnet twin cone	£6 0 0
3. Duode de luxe, D.C. model	£6 10 0
4. Duode de luxe, A.C. model	£7 15 0
Conversion of the standard energised model (now withdrawn) to Duode de luxe	£2 10 0
Conversion of original Duode to Duode de luxe	10 0
Transformers, for all types	£1 0 0

HT

HARTLEY TURNER RADIO LTD.,
THORNBURY ROAD,
ISLEWORTH, MIDDLESEX.
Telephone: HOUnslow 4488

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DEPOSIT SYSTEM

Readers who hesitate to send money to advertisers in these columns may deal in perfect safety by availing themselves of our Deposit System. If the money be deposited with "The Wireless World," both parties are advised of its receipt.

The time allowed for decision is three days, counting from receipt of goods, after which period, if buyer decides not to retain goods, they must be returned to sender. If a sale is effected, buyer instructs us to remit amount to seller, but if not, seller instructs us to return amount to depositor. Carriage is paid by the buyer, but in the event of no sale, and subject to there being no different arrangement between buyer and seller, each pays carriage one way. The seller takes the risk of loss or damage in transit, for which we take no responsibility. For all transactions up to £10, a deposit fee of 1/- is charged; on transactions over £10 and under £50, the fee is 2/6; over £50, 5/-. All deposit matters are dealt with at Dorset House, Stamford Street, London, S.E.1, and cheques and money orders should be made payable to Iliffe & Sons Limited.

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NEW RECEIVERS AND AMPLIFIERS

A

AIR KING,

THE Royalty of Radio.

ALL Models Feature Beam Tuning, Magic Eye indicator, gramo. pick-up connections, and special output valves.

ALL Sets Fully Guaranteed; H.P. terms available from 3/- per week; our technical department is at your service.

WHOLESALE and Trade Enquiries Invited; generous terms.

ARCTURUS Valves for Improved Radio Reception on All Types of Receivers.

WRITE for Lists of These Famous Valves; prices from 4/9 each.

AIR KING RADIO, 115, Shaftesbury Av., Cambridge Circus, W.C.2 (1st floor above Barclay's Bank). 'Phone: Temple Bar 4875 (all lines). All receivers assembled in England. [3406

"SERVICE With a Smile."

HENRY FORD RADIO, Ltd.,

ELECTRONIC House, 22, Howland St., Tottenham Court Rd., W.1. Museum 5675. [0511

STATEMENT of Policy.

THE policy of the Coulphone Radio Mfg. Co., Ltd., of Hutton, Preston, Lancs, is to produce high class radio at a reasonable price; this has been done since 1923; in fact, some over-enthusiastic clients are still using sets built by us in 1924. Example of our productions:—8-VALVE 8-watt 4-waveband, pre-H.F., 2 I.F. stages, 10in. speaker, walnut cabinet; £20. If a better set could be made we would make it; 12 months' guarantee, including valves.—'Phone: Longton 196. [3802

G5TS Presents the "Hallicrafter."

EVERY Instrument Perfectly Adjusted and Tested on the Air Personally.

"SKYBUDDY," complete with valves, speaker, etc.; £9.

"ULTRA-SKYRIDER," with crystal gate valves, etc.; £34.

"SKYCHIEF Super-Skyrider and Commercial," available 14 days.

BLUE-PRINT, full operating data, with all receivers; carriage free anywhere in British Isles. Terms, cash with order or c.o.d.

T. BRIAN SMITH, 115, Novar Drive, Hyndland, Glasgow. [3753

ENQUIRE About Harmaur Radio 1937 Receivers.

AMERICAN-BOSCH "CentrOmatic" All-wave Sets.

FREED-EISEMANN Receivers as Bought by the B.B.C. and "The Wireless World."

PIERCE AIRO AC/DC All-wave and Car Radios.

RAYTHEON Valves. Trade enquiries.

THE HARMAUR RADIO Co., Ltd., 8, Clifford St., New Bond St., London, W.1. [0499

NEW RECEIVERS AND AMPLIFIERS

ANGLO AMERICAN RADIO Offer the Finest Range of Chassis and Receivers at London's Lowest Prices.

50/-.—Exceptional bargain; Multi-band (7-2,000 metres) Communications outfit, battery, valves, 8in. speaker, metal cabinet, 7in. dial, with S.W. station names, band-spread together with 8in. world rotating globe on stand.

70/-.—A.C./D.C. 4 Communications outfit, var. mu., H.F., Pen. det., output Pen. rectifier, 100-250v. specification, otherwise as above.

67/6.—All-wave battery chassis, S.G. H.F. Pen-det.-Pentode, 16-2,000 metres, 3 bands, latest all-wave slow motion dial calibrated in metres, P.U. and extra speaker sockets, an excellent home receiver; supplied direct from prominent British manufacturer, 8in. moving coil speaker, 10/6; horizontal type cabinet, 12/6.

£5/19/6.—7-valve all-wave chassis, 3 bands, 16½-2,000 metres coloured tuning dial calibrated, visual cathode tuning, full A.V.C., A.C./D.C., 110-240v., exceptional performance; matched speaker, 10/6; cabinet, 12/6.

£7/19/6.—8-valve all-wave chassis, 16-2,100 metres, new De Luxe 5½in. airplane multi-indication dial A.V.C., tone control, calibrated all bands, 110-240v. A.C./D.C.; matched speaker, 12/6; cabinet, 14/6.

£8/19/6.—8-valve all-wave chassis, 16-2,100 metres, visual cathode tuning, 7½in. super airplane multi-indication dial, 4 watts output, A.V.C., tone control, A.C. operation, 110-240v.; matched speaker, 12/6; horizontal type cabinet, 15/6.

£5/19/6.—Car Radio 5-valve superhet, highly efficient, A.V.C., tone control, illuminated dial, magnificent performance, complete with suppressors and sundries and complete operating and fixing instructions; demonstrations under London traffic conditions daily.

CABINETS Offered With Chassis are of Finest Quality and Finish, and as supplied by manufacturers with chassis; where cabinets are ordered with chassis these are despatched fitted as complete receivers.

3D. Stamp Brings Complete Lists Receivers, short-wave components, covering every radio need; London's lowest prices throughout; terms: cash with order or on delivery.

ANGLO AMERICAN RADIO (AND MOTORS), Ltd., (Dept. W.4), Albion House, New Oxford St., London, W.C.1. (Telephone: Temple Bar 3231.) [3761

ARMSTRONG COMPANY Manufacture 8 Radio Receivers in Chassis Form, briefly described hereunder.

ARMSTRONG 6-valve All-wave Superheterodyne Radiogram Chassis, for A.C. mains, complete with Rola speaker; £7/10.

ARMSTRONG 8-valve 4 Wave-band Radiogram Chassis, with phase reversed push-pull output; £9/17/6.

ARMSTRONG 6-valve 4 Wave-band Radiogram Chassis, with large triode output; £8/17/6.

ARMSTRONG 8-valve 4 Wave-band Radiogram Chassis, with radio-frequency stage and push-pull output; £11/11.

ARMSTRONG 7-valve 4 Wave-band Radiogram Chassis, with radio-frequency stage and single triode output; £10/10.

ARMSTRONG 8-valve 2 Wave-band Radiogram Chassis, with 8 watt push-pull output; £8/10.

ARMSTRONG 6-valve 2 Wave-band Radiogram Chassis, with single large triode output; £7/10.

ARMSTRONG Chassis Carry 12 Months' Guarantee.

ARMSTRONG Chassis are Sent 7 Days' Trial, carriage, packing, and crate free.

ARMSTRONG MANUFACTURING Co., 100, King's Rd., Camden Town, N.W.1. [3460

CHASSIS, Peerless latest American 9-valve, 3-wave, 8in. speaker, £9/15; ditto, 11-valve 5-wave, 12½ speaker.—Kay, 1, Old Church Lane, N.W.9. [0547

"WIRELESS World" Quality Amplifiers and Feeder Units, full kits of parts supplied, various amplifiers for disposal; free advice given on type of speakers, valves to be used, etc.; write or call.

W. T. RICKARDS, Certified Radio Engineer, 17, Heathfield Rd., King's Heath, Birmingham. [3809

PILOT, Ferguson, Pegasus and Air King all-waves lead the field; our deliveries are prompt in original cartons with full guarantees; your trade card will bring our wholesale catalogue from the authorised distributors.—Leonard Heys, 36, Henry St., Blackpool. [0530

THE Best is the Cheapest.—For receivers that will please you, write to W. J. Rayner and Co., Ltd., for details of Masterpiece sets, of which we are sole agents, and the satisfying Silvertone receivers.—162, Farringdon Rd., E.C.1. 'Phones: Hop 1091, Clerkenwell 1876. [3772

RECEIVERS AND AMPLIFIERS
CLEARANCE, SURPLUS, ETC.

HENRY'S.

SHORT-WAVE Units by Well-known Manufacturer, 13-70 metres, supplied in handsome walnut cabinet, complete with coils, adaptors and instructions, no alterations to your present set, one plug connection, for all A.C. mains or battery sets, listed at £3/3; our price 30/-, carr. pd., in sealed cartons.

HENRY'S, 72, Wellington Ave., London, N.15. Stamford Hill 2907. [3759

CLEARANCE List (Trade Only).—Write Leonard Heys, 36, Henry St., Blackpool. [0527

A BARGAIN List of New Sets from 75/-.—Write Kay, 1, Old Church Lane, N.W.9. [0535

BATTERY CHARGING PLANT

CARFAX "Junior," 20/30v., 5a., £5/5; guaranteed five years.—British Rectifiers, Vernon Place, Cheltenham. [3573

WESTINGHOUSE 4-circuit Battery Charger, style RGC1, A.C. mains, present price wholesale £44; bargain, £22 or near offer.—Friede, 92, Harrington Rd., South Norwood. 'Phone: Addiscombe 3272. [3784

Notes No. 25.

on the Suppression of Electrical Interference with Wireless Reception

We wonder how many of our readers (especially in dealers' premises) can listen to Luxembourg without crackle. Only in very rare cases is it necessary to put up with the interference, and if you are troubled with it, write and tell us now, and give us the chance of advising you. This invitation is specially offered to the trade.

Recently we had a bad case of neon interference where it was necessary to demonstrate receivers such as R.G.D. 12-valve radio gramophones in a room on the first floor of self-contained premises, *three* sides of which were fitted with large neon signs giving rise to fierce interference. In all, eleven transformers were used in the tube installation, and in view of the likely cost, it was decided that every effort should be made to effect suppression by other means than by fitting chokes to the signs, the interference from which was very local and not known to trouble neighbours. A 35-ft. aerial was inside the roof, and the lead-in was screened, but without advantage. It was found possible to take a high 100-ft. span aerial from the top of the premises to the back directly away from the building, and to fit an* "Eliminoise" all-wave anti-interference equipment. An earth was connected to the screening of the transmission line, close to the corner of the building from which the aerial was attached.

A very great reduction in noise was brought about without any noticeable drop in programme strength. Originally the London stations and Droitwich were definitely not receivable without an equal level of interference. Since the fitting of the "Eliminoise" these stations could be received at satisfactory programme value, and, in addition, Radio Paris, Luxembourg, Fecamp and North Regional were worth listening to.

Each year hundreds of thousands of improved receivers are bought by listeners. In many cases they are "installed free of charge," with a piece of wire hung about indoors for an aerial, and no earth. A modern receiver will work under these conditions, but is it then worth the money paid for it? If you know of such cases advise getting in touch with someone who knows what to do. Avoid the dabbler like the plague, and remember a brilliant engineer might be a dabbler in the suppression of interference. When in doubt write to us. If we cannot put you on to someone in whom we believe, we will advise you direct.

* "Eliminoise" (Trade Mark) 35/-.

Send for book "Interference Suppression," post free 1/2, or for free copy of "The Eliminoise System" and other relative literature.

BELLING-LEE
SUPPRESSION SERVICE

Belling & Lee Ltd.
Cambridge Arterial Road,
Enfield, Middx.

PUBLIC ADDRESS EQUIPMENT

SPECIAL Offer!!!

8½ Guineas Assembled: Vortexion 20 watt 4-stage P.A. amplifier, in steel case, 8in×10in.×9in. high, with carrying handle, input with controls for microphone and pick-up and tone control, output for 7½ and 15 ohm speakers, weight 25lb.; only 8½ guineas, with valves.

4 Input Model, with mixers; £10.

HEAVY Duty Model, as fitted to cinemas and dance halls; £15.

CALL and Hear the Rumble of an Organ as Never Before on our Wide Frequency Range Models, the best yet.

VORTEXION, Ltd., 182, The Broadway, Wimbledon, S.W.19. See also New Mains Equipment. [3439

PARTRIDGE P.A. Manual, free to trade. See "Partridge Transformers" under "New Mains Equipment." [3487

HARMONY HOUSE SOUND SERVICE, Southport.—Beam power amplifiers, 14 watts output; £13/10 (subject); send for lists. [0546

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AT 5/3 Each.—F.C.4 type, Pen.4V.B. type, F.W.350-120 m.a., battery valves, H.F., L.F., det., 2/2; power, 2/6; S.G., V.M.S.G., Pentodes, H.F. Pen., V.M.H.F. Pen., 4/9.

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Screened Grid—S.G. Det.—2 L.F.	SG–vSG–2
Plug-in Adaptor and 2 L.F.	Av–2
Convertor and 2 H.F.—Det.—2 L.F.	C + 2–v–2
Convertor, and superhet, receiver (6-valve)	C + SH6

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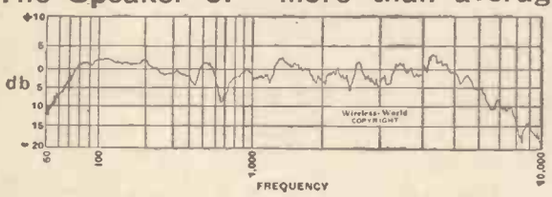

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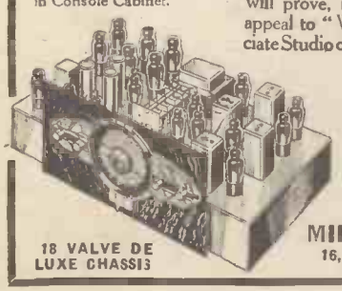

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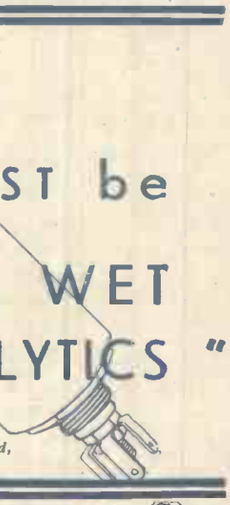

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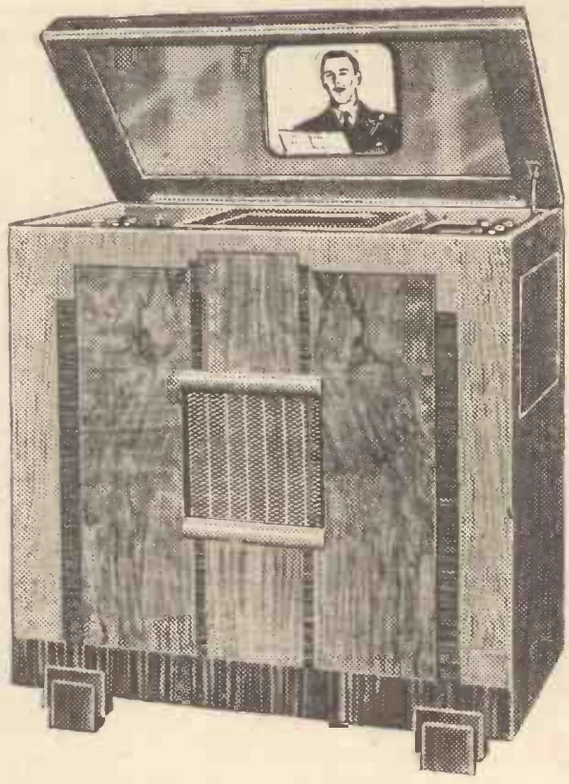

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The Wireless World

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26th Year of Publication

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As many of the circuits and apparatus described in these pages are covered by patents, readers are advised, before making use of them, to satisfy themselves that they would not be infringing patents.

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EDITORIAL COMMENT

Television Progress

Significance of Recent Events

OUTSTANDING decisions in regard to television which have been taken recently are likely to have a profound influence in speeding up not only the popularity of television but also the efficiency of the transmission end and the attractiveness of the programmes.

The Television Committee's decision to adopt the higher definition system of Marconi-E.M.I. without an alternative unless presumably some alternative system of equal or better definition should be developed, means first that all the transmissions will now be of a higher standard; secondly, that receiver manufacture will be somewhat simplified; and thirdly, the B.B.C. programme production staff will have more space available at Alexandra Palace and a better medium all the time for the exercise of their skill and ingenuity in the development of entertaining and valuable programmes.

The reduction in the price of television sets is a matter which scarcely requires that we should point out its importance. It is a bold move to have made, but we believe that it will prove in the long-run to be a direct gain to manufacturers, because a larger production, with the economies which this makes possible, will result. The decision, too, that sets will be available on a gradual purchase basis should do much to stimulate sales.

During the last few weeks particularly, the programmes from Alexandra Palace have improved so much that we feel it is unfortunate that there is no record of what they were like at the beginning of the service, in order that direct comparison could be made. If with the handicap of two systems and duplicate studios so much has been achieved, we can look forward to spectacular progress in the near future, and feel sure that more funds will be available to the energetic producers as the value of their work increases. We feel that it would be only fitting here to pay tribute to the B.B.C. television staff for the great strides which they have made recently, as they become more familiar with the distinctive technique which is called for in the production of programmes for television requirements.

Radio Receivers

Specification for Testing and Performance

THE Radio Manufacturers' Association has recently prepared, primarily for the information of their members, a "Specification for Testing and Expressing Overall Performance of Radio Receivers."

The publication is divided into two parts, the first dealing with electrical tests and the second with acoustic tests. This publication would, we feel, prove of interest to a large number of our readers, and the R.M.A. have therefore agreed to extend the distribution of this publication to those of our readers who may care to apply for it to the offices of the R.M.A., Astor House, Aldwych, W.C.2. A charge of 2s. for each part will be made to meet the cost of printing.

The specification has been the subject of a discussion at a meeting of the Wireless Section of the Institution of Electrical Engineers recently, and some criticism was made respecting some sections of it. The R.M.A. are anxious to emphasise that they do not regard this specification as representing finality in any way, and they would heartily welcome constructive criticism from our readers, with a view to improving the publication and increasing its value in future editions.

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Magnetic Deflection

By J. H. REYNER, B.Sc., A.M.I.E.E.

ALTHOUGH the electrostatic method of deflecting the beam in cathode-ray tubes is best known, the alternative system of magnetic deflection is now so widely used, especially for television, that a knowledge of it is essential for a proper understanding of modern practice.

THE cathode-ray tubes normally in use in this country employ electrostatic deflection. But it is also possible to deflect the electron beam magnetically—a fact which the user very quickly discovers, any stray magnetic fields from transformers causing quite serious distortion. Assuming that such unwanted and spurious deflections are suitably disposed of, the question arises whether magnetic deflection cannot be put to some use. American technique in particular has rather favoured this method of producing the necessary beam movement.

One advantage of the method is that the tube itself is simplified. The necessity for accurate alignment of the elements is responsible for a considerable proportion of the cost of a cathode-ray tube. The deflector plates must be correctly at right angles and they must be centrally located relative to the gun, or the beam will hit one of the plates before full deflection has been obtained. By omitting the plates altogether some of this work is eliminated with consequent reduction in cost. As against this, of course, must be set the cost of the necessary magnetic deflecting system.

The procedure is to locate two coils on either side of the tube as indicated in Fig. 1. An iron circuit is employed to decrease the magnetic reluctance and also to concentrate the magnetic flux in the region where it will be most useful. This may be of a U or a ring type, and owing to the relatively large air gap there is little to choose on the score of efficiency between the two.

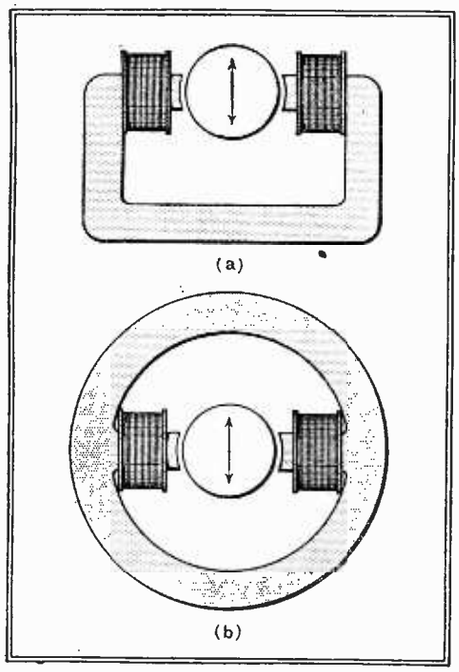

Fig. 1.—Two methods of mounting deflecting magnets on a cathode-ray tube ; the arrows indicate direction of deflection.

THE ALTERNATIVE METHOD OF CATHODE-RAY CONTROL

The deflection produced is at right angles to the magnetic field so that for a vertical scan the axis of the coils is located horizontally across the tube. The coils should be accurately lined up and the axis must be truly horizontal as otherwise the deflection will not be correctly vertical. A small movement up or down relative to the tube does not cause any serious difficulty, because the magnetic field from the pole pieces spreads out in the manner shown in Fig. 2. The beam at the point of deflection is, of course, substantially central. Even at maximum deflection the forward end does not deviate more than about one eighth of an inch, so that provided the field is uniform for this distance on either side of the axis, satisfactory deflection will result.

The coils must not be too much off centre, however, or the effective part of the field will be non-uniform and the deflection of the beam will no longer be linear.

Amplified Impulses

The deflection produced is proportional to the current so that we must arrange a saw-tooth current variation in some way. Fig. 3 shows a skeleton circuit suitable for doing this. A normal time base is employed feeding an amplifying valve, in the anode circuit of which are included the deflecting coils. The time base, if correctly designed, will supply a linearly increasing voltage with a sharp flyback at the end of the cycle, and the circuit must be designed so that the anode current follows this voltage variation faithfully. There are two factors which militate against this, the first being the curvature of the valve characteristic and the second being the time constant of the deflector coils.

The former tends to reduce the deflection at the end of the sweep, giving the same effect as non-linearity in the time base, while the inductance of the coils slows up the increase of current at the beginning of the cycle and tends to make the deflection lag behind the voltage which is producing it over the whole of the scan. Both these defects can largely be compensated by including a high resistance in series with the coils, and such a resistance is shown in Fig. 3.

In order that the valve shall still be capable of handling a satisfactory current swing, the high-tension voltage applied to the amplifying valve must be suitably increased, from 800 to 1,000 volts being usually desirable. The anode resistance

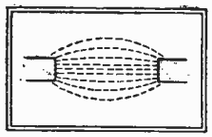

Fig. 2. — Illustrating the spreading of a magnetic field.

depends upon the conditions, but a value of 50,000 to 100,000 ohms is usually satisfactory. The coils must be designed to give the necessary ampere-turns with a change of current within the capabilities of the valve. Actually the choice of anode load is rather critical, and for any particular valve there will be found a particular resistance and HT voltage which give the best results. A typical example is reproduced in Fig. 4, where dynamic characteristics are shown for a Hivac AC/L valve under three different conditions. One of the three will be seen to be outstandingly better than the others (Ra = 50,000 ohms; HT = 800V) giving a linear sweep over a current range of some ten milliamps., which is more than enough for normal purposes.

It is necessary to provide some method of compensation for the steady anode current through the coils, for unless this is done there will be a fairly large permanent deflection. This is best accomplished by arranging a reverse voltage feed through a high resistance across the coils themselves. A small bucking eliminator can be provided for this purpose or voltage may be supplied in the right sense from a tapping a few volts more positive than the normal HT line, as in Fig. 3. A high resistance or choke should be included to avoid shunting the coils, and, by making

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Magnetic Deflection—

a portion of the resistance variable, the position of the scan on the tube will be altered, so that this adjustment replaces the ordinary electrostatic shift.

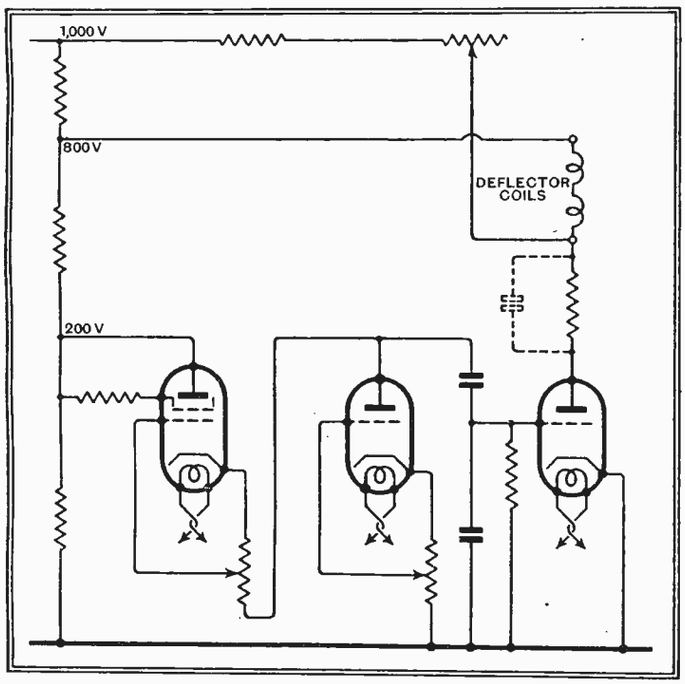

Fig. 3.—Simple magnetic scanning circuit with shift.

The modern high-vacuum tube is usually provided with push-pull deflection to avoid the de-focusing of the spot at the edges of the sweep and to prevent trapezium distortion. It is natural, therefore, to query whether push-pull deflection should not be used for magnetic scanning. Push-pull deflection, of course, would largely overcome the permanent deflection due to the steady anode current, and the need for the bucking eliminator would not arise. Unfortunately, any attempt to apply push-pull deflection to the simple circuit of Fig. 3 leads to unsatisfactory results.

De-focusing

This arises mainly from a de-focusing of the spot. It is well known that the electron beam can be focused by magnetic means, for which purpose it is customary to place a coil axially round the neck of the tube, thus producing a magnetic field along the tube parallel with the electron beam. Now, if we use push-pull deflection, the steady magnetic fields produced

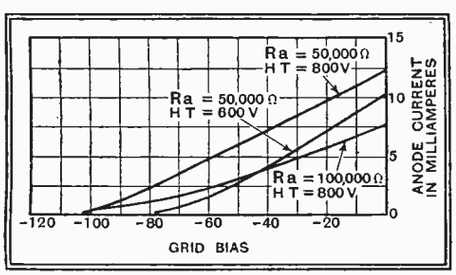

Fig. 4.—Dynamic characteristics of AC/L valve.

by the two coils will be in opposition (although, of course, as far as the deflection is concerned, current through one coil will increase while that through the other decreases). This opposition of the two magnetic fields causes a spreading effect as indicated in Fig. 5; this effect will be seen to give rise to quite a considerable axial component of the field, and this defocuses the spot. Moreover, no readjustment of the electrostatic focus by varying the gun potentials appears to be able to correct for this.

It is, of course, possible to avoid this trouble by arranging to filter out the DC component of the current, feeding the valve through a choke and by-passing the varying scanning current through a condenser on to the coils. In these conditions the defocusing described does not appear.

The advantage of such a course, however, is problematical. A series resistance of from 10,000 to 50,000 ohms is still desirable in the coil circuit to minimise the time lag due to the inductance of the coils, which in turn necessitates a feed choke having an impedance at the scanning frequency of at least a comparable order—no mean requirement when it is remembered that, at 25 cycles, 10 henries represents only 1,570 ohms.

This argument would not carry much weight if push-pull deflection were really necessary, but a closer examination shows that it is not essential with magnetic deflecting arrangements. The de-focusing of the spot at the edges of a normal electrostatically scanned tube arises from the fact that the deflector plates, being effectively connected to the anode, act as a part thereof, so that the voltage on the deflector plates is added to or subtracted from that on the anode, which upsets the potential distribution of the focusing system. Trapezium distortion arises from the same cause, for the deflection of the beam is dependent upon its velocity, which is again controlled by the gun voltage, and if this is effectively varying due to the altering potentials on the deflector plates, it is clear that the sensitivity at one end of the scan will be different from that at the other end.

Neither of these effects arises when dealing with magnetic scanning. The potential on the third anode is quite unaffected by the scanning circuit, so that a straightforward scan will give a satisfactory deflection in both directions without trapezium distortion and without de-focusing, provided that we ensure that there is no axial component on the magnetic field.

It is because of this difficulty that two deflector coils are used, one on each side of the tube. Certain simplifications would appear to be possible by locating a deflector coil on the neck of the iron circuit and thereby using only one coil instead of two, but this permits quite an appreciable stray field to be produced. Moreover, it is a well-known axiom in magnetism that with a circuit having a large air gap the magnetising force (i.e., the coil) should be applied as close as possible to the air gap and, in fact, should really be located around the air gap itself. This is impracticable because we have the tube in the way, but we can approximate to the required conditions by having two coils, one on each side, as close as reasonably practicable to the tube itself.

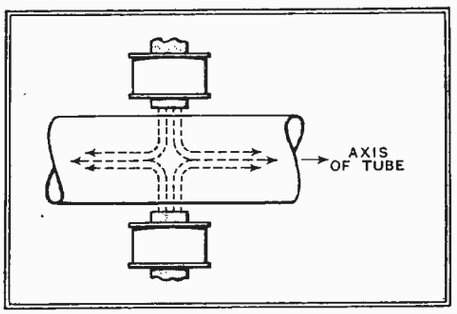

Fig. 5.—Illustrating de-focusing effect with push-pull deflection.

With these precautions, magnetic scanning can be made to give quite satisfactory results, particularly at low frequencies. For high-frequency scanning the problem is a little more difficult owing to the fact that the inductance of the coil has much more effect, but it is impossible to deal with this question in the present article. Reference, however, may be made to one difficulty which is still experienced even with low-frequency scans, and this is the question of the flyback. Although the sweep itself may be taking place in 1/25th or 1/50th of a second, the flyback is required to occur much more rapidly.

The ordinary time base has a limited flyback speed, being somewhere about 5 per cent. of the charging time, but a magnetic deflection circuit will often be found to take much longer.

This, of course, arises from the much higher speed of the flyback, so that the inductive reactance of the coils is no longer negligible, and in practice the flyback time may be sufficiently long to cause trouble. In a television image, however, the period occupied by the low frequency synchronising impulse is long enough to cover quite a slow flyback, and trouble on this score is unlikely.

If any difficulty does arise it may be remedied by connecting a condenser across the anode resistance in the amplifying valve as shown dotted in Fig. 3. The value of this condenser should be such that it presents a high impedance relative to the anode resistance at the normal scanning frequency of 25 or 50 c/s, but acts as quite an appreciable shunt at the

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Magnetic Deflection—

flyback frequency. This permits the energy contained in the magnetic circuit to be dissipated much more quickly, and the flyback time can be cut down to a suitable value. These conditions are fulfilled at normal picture speeds with a condenser of the order of 0.01 mfd.

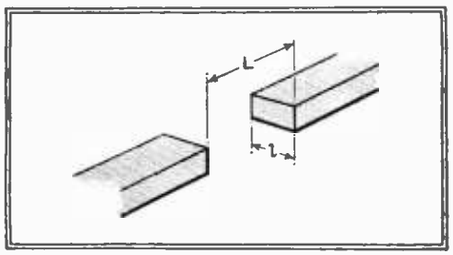


Fig. 6.—Measurement of dimensions of pole-pieces for estimating deflection.

It is clear, therefore, that, when properly handled, magnetic scanning can be used quite successfully. Difficulties do arise in connection with the high-frequency scan for a television circuit, but these can be overcome, and, in fact, one manufacturer has gone even farther, and is using magnetic focusing as well, so that his cathode-ray tube consists merely of a cathode, a grid and a single anode—a saving in the cost which more than compensates for any slight extra complexity in the scanning.

APPENDIX

Estimation of ampere-turns required

The deflection produced by a magnetic field is proportional to the field strength, and to the width of the field along the axis of the tube. Thus it pays to use elongated pole-pieces as shown in Fig. 6. There is no advantage in a small pole-piece, because the air gap is so large that the iron produces little concentration of the flux, serving mainly to provide an easy return for the flux after it has crossed the gap.

The deflection is also inversely proportional to $\sqrt{V}$ (not to V as with electrostatic deflection) the sensitivity usually being expressed in the form.

$Dm. = kl/\sqrt{V}$ mm. per gauss.

where l is the axial length of the field in mm.
V is the gun voltage and
k is a constant depending on the structure and size of the tube.

The gauss is the unit of magnetic field and is equal to one line per sq. cm.

Again, owing to the large air gap, the magnetic field is practically equal to the magnetising force, the iron only increasing the field by a small percentage. Hence, very nearly, the magnetic field is given by

$H = 1.257\ In/L$

where I is the current in the coils (in amps.)
n is the total number of turns and
L is the length of the magnetic circuit in cm.

Because the air gap is responsible for nearly all the reluctance of the circuit, L may be taken simply as the length of air gap between the pole pieces.

A typical example will show the order of deflection obtained. The Cossor 3273 tube has a magnetic sensitivity of $8l/\sqrt{V}$ mm. per gauss. The distance L between the pole pieces must be 4.5 cm. to accommodate the tube. If our pole pieces are 15 mm. long and we assume l to be the same then at a gun-voltage of 4000 the sensitivity is $\frac{8 \times 15}{63.2} = 1.9$ mm. per gauss.

For a deflection of 6 cm. we should therefore require $60/1.9 = 31.6$ gauss $= 1,257\ In/4.5$

whence $In = 113$

If the change in current through the coils can be 10 mA, then $n = 11300$.

HOME MADE MICROPHONE

A Miniature Lapel Instrument

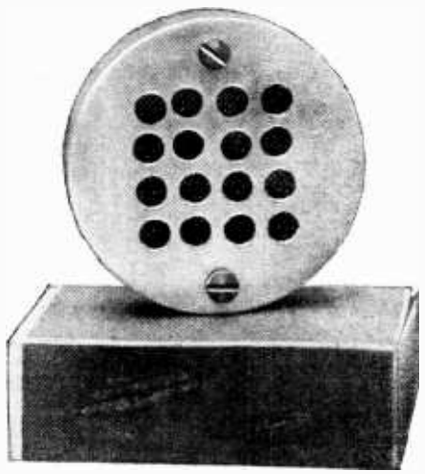
By RICHARD H. McCUE

THE microphone shown in the accompanying illustration was really built in order to use up a small quantity of high-quality granules, which were left over after two or three models of the *Wireless World* carbon microphone[1] had been made. At the same time it was desired to see whether the transverse current principle could be applied successfully to a miniature "lapel" type instrument.

The results are surprisingly effective, the output for an equal polarising voltage being not very much less than that of the full-size instrument. The quality, although not so good, is satisfying and quite passable with such a searching test as the transmission of piano music. The main disadvantage seems to be the relatively high background noise; this, however, is not obtrusive when a single dry-cell is used for polarising, at which voltage the microphone passes about 3½ milliamperes.

[1] Issue of January 11th, 1935. Reprints (revised and extended) available from the Publishers; price 2d. post free.

In principle, of course, the instrument is exactly the same as the original *Wireless World* microphone, but it is constructed on a much reduced scale and with slightly different proportions. The body is cut from a piece of hard vulcanised fibre 1¾in. diameter and 7/16in. thick (actually this could have been made smaller). The granule trough is ⅜in. square by 3/32in. deep, and the carbon electrodes ¼in. square by ⅞in. A very thin piece of mica—rather less than 0.001in. —was chosen for the diaphragm, and the celluloid spacer was cut from an old car side-curtain. The front plate of the instrument is of polished sheet aluminium, drilled with sixteen 3/16in. holes, and a small piece of the metallised fabric used for loud-speaker frets is interposed between the front plate and spacer. If the instrument is to be used as a "lapel mike" a brooch pin or small metal clip should be fastened under one of the clamping screws which hold the parts together. The user should then speak in a perfectly natural way, forwards and outwards—forgetting all about the microphone, in fact, except to remember that it is somewhat sensitive to taps and jolts.



The miniature microphone compared with a box of matches.

Television Programmes

Transmission times are from 3-4 and 9-10 daily.

Vision	Sound
45 Mc/s	41.5 Mc/s.

FRIDAY, FEBRUARY 19th.

3, Alexandra Park Grounds described by Leslie Mitchell. **3.5,** Friends from the Zoo, introduced by David Seth-Smith. **3.25,** Gaumont-British News. **3.35,** Cabaret. **3.50,** Gillie Potter.

9, Cabaret. **9.15,** British Movietonews. **9.25,** A Physical Training Display by instructors of the Army School of Physical Training. **9.40,** Film. **9.50,** Starlight.

SATURDAY, FEBRUARY 20th.

3, Scott Gordon's Marionettes. **3.10,** British Movietonews. **3.20,** Cabaret.

9, A Film Star Interviewed. **9.10,** Scenes from Shakespeare's "Twelfth Night." **9.25,** Gaumont-British News. **9.35,** Variety.

MONDAY, FEBRUARY 22nd.

3, Edward Shackleton. **3.20,** British Movietonews. **3.30,** Cabaret.

9, Edward Shackleton. **9.20,** Gaumont-British News. **9.30,** Cabaret.

TUESDAY, FEBRUARY 23rd.

3, Comedy Act. **3.10,** The World of Women: Houses or Homes? **3.25,** Gaumont-British News. **3.35,** Vauxhall: A Masque.

9, Repetition of 3.10 programme. **9.15,** Commander A. B. Campbell talks about card-sharpers at sea. **9.25,** Repetition of 3.35 programme. **9.50,** British Movietonews.

WEDNESDAY, FEBRUARY 24th.

3.5, Modern Art in Stage Design: Discussion. **3.20,** British Movietonews. **3.30,** Thirty-first Picture Page.

9.5, Repetition of 3.5 programme. **9.20,** Gaumont-British News. **9.30,** Thirty-second Picture Page.

THURSDAY, FEBRUARY 25th.

3, Dress Parade: A Forecast of Fashions in day clothes. **3.15,** Gaumont-British News. **3.25,** Home Affairs: Unemployment discussed by John Hilton and Sir William Beveridge. **3.40,** Film. **3.55,** Songs at the Piano.

9, Repetition of 3 programme. **9.15,** British Movietonews. **9.25,** Repetition of 3.25 programme. **9.40,** Film. **9.50,** Music Makers.

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ATC Systems

HOW AUTOMATIC TUNING CONTROL WORKS

IN order to prevent any possibility of inaccurate tuning, methods have been devised for making the receiver tune itself. With such systems tuning is primarily carried out manually in the usual way, but a secondary electrical system takes charge when the tuning is nearly correct. ATC is in general suitable only for the superheterodyne and it functions on the oscillator circuit; it consequently corrects not only for inaccurate tuning but also for wandering of the oscillator.*

MOST users of selective receivers realise the importance of correct tuning if good quality reproduction is to be secured, for every time they tune to a fresh station they necessarily pass through regions of incorrect tuning in leaving the one station and approaching the other. Quite a small degree of mistuning can completely alter the frequency response characteristics of the receiver, and worse still, it can cause severe amplitude distortion. This effect arises because the carrier can actually become weaker than its accompanying sidebands when they arrive at the detector, and this portion of the apparatus cannot be free from distortion under such conditions.

In the hands of anyone with a critical ear the effect is not of importance, for it is easy to tune the set accurately, while the non-skilled are greatly assisted in the attainment of the correct results by a visual tuning indicator. In the case of a superheterodyne, it is the tuning of the oscillator which is important, for it has, in effect, the whole selectivity of the IF amplifier behind it and this is usually 99 per cent. of the selectivity of the whole receiver.

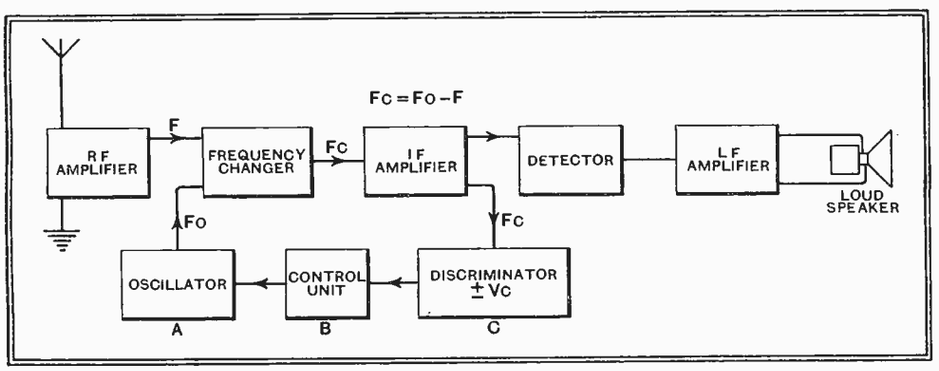

Fig. 1.—A schematic diagram showing the general arrangement of a receiver including automatic tuning.

Any wandering of the oscillator frequency, therefore, may seriously mistune the set, even although the tuning controls have not been touched. It is not difficult to construct oscillators of adequate stability for the medium waveband, but it is a much more difficult problem on short waves. It is clear, therefore, that a method which automatically corrects for small amounts of mistuning is of importance, for not only does it compensate for variations in the oscillator frequency, but it makes it unnecessary for the operator to tune carefully. The set itself sees that it is tuned correctly!

The degree of constancy of oscillator frequency needed for short-wave reception is quite high. The ideal IF bandwidth is of the order 10-20 kc/s; the frequency of the oscillator may be 10-20 Mc/s. It will need, therefore, to be stable to a few parts in a thousand if the station is to be retained correctly in tune. A drift of 5 parts in a thousand in a selective receiver tuned to 20 Mc/s is sufficient completely to lose the wanted transmission.

The drift of the oscillator frequency can be due to a variety of causes; to the gradual heating of the valve, the tuning coil or condenser, to changes in the mains supply voltage, to vibration or to mechanical instability in any of the elements determining the oscillator frequency. Probably the most potent of these causes is the gradual heating of the oscillator tuning coil by heat from the valves and mains transformer. Any one of these causes is sufficient to cause frequency changes of the order mentioned, even when precautions have been taken to secure the best possible oscillator stability.

The problem resolves itself then into automatic electrical or mechanical control of the frequency of the oscillator, so that the difference between the signal carrier frequency and the oscillator frequency is always nearly exactly equal to the mid-band intermediate frequency. Referring to the schematic of Fig. 1, C is a discriminator and B a control unit which together operate on the oscillator associated with the frequency-changer valve to adjust the difference frequency Fc to the correct valve Fmb.

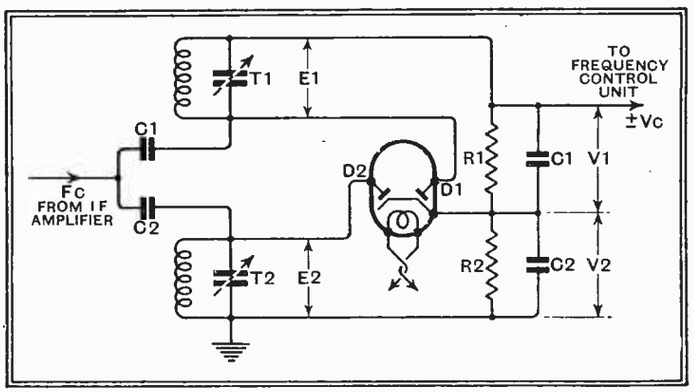

Fig. 2.—The circuit of a discriminator which provides a DC output, the polarity of which depends upon whether the intermediate frequency is too high or too low.

The Discriminator Circuit

It is the function of the discriminator to provide a direct voltage Vc which changes sign as the intermediate frequency Fc passes through the mid-band value Fmb. This direct voltage applied to the control unit B produces a change in the frequency of oscillator A tending to change it in such a way as to make Fc approach Fmb. When Fc is correctly located on Fmb, then the direct voltage is required to be zero.

This discriminator circuit is commonly of the differential type as shown in Fig. 2.

* *The Wireless World*, January 10th, 1936; *The Wireless World*, November 27th, 1936.

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The tuned circuits T1 and T2 are supplied from the intermediate frequency amplifier through small coupling condensers C1, C2. They are tuned to frequencies above and below Fmb by an amount $\pm \frac{1}{2} \frac{Fc}{Q}$ where Q is the effective step up or magnification factor $\frac{\omega L}{R}$ of the tuned circuit. (The full Q of the coil is not obtained owing to the damping of the diode).

When this is so, the response curves of the two circuits cross at $1/\sqrt{2} = 0.71$ of the maximum response. This fact is useful in lining up the circuits, since the tuning can be adjusted so that the rectified current passed by either diode is 0.71 of the maximum, assuming linear rectification. The rectified voltages V1, V2 across R1 and R2, due to E1, E2 add in series and the control voltages $Vc = V2\text{-}V1 \propto \sqrt{2}$ (E2—E1). With the differential type of circuit the control voltage passes through zero when $Fc = Fmb$ and the control voltage at correct tune is independent of the signal amplitude, otherwise it would be possible to work on the side of a single resonant circuit. The time constant of the R1, C1, R2, C2 circuits should be long enough not to follow the lowest frequencies of modulation on the carrier, but quick enough to follow up a fairly rapid drift of the oscillator, a value of $\frac{1}{4}$ second up to a few seconds might be used. R1 and R2 should be $\frac{1}{2}$ to 2 megohms in order not to keep the damping on the tuned circuits T1, T2 at a minimum.

The range of control may conveniently approximate to the IF band-width of the receiver, i.e., 5-10 kc/s. If Q = 100 and an IF of 450 kc/s is used, then the control is effective over 4.5 kc/s.

We have now a discriminator circuit capable of producing direct voltage roughly proportional to the error in tuning and changing sign with it. The next problem is to apply this direct voltage to a control valve capable of operating on the oscillator to change its frequency in the required direction.

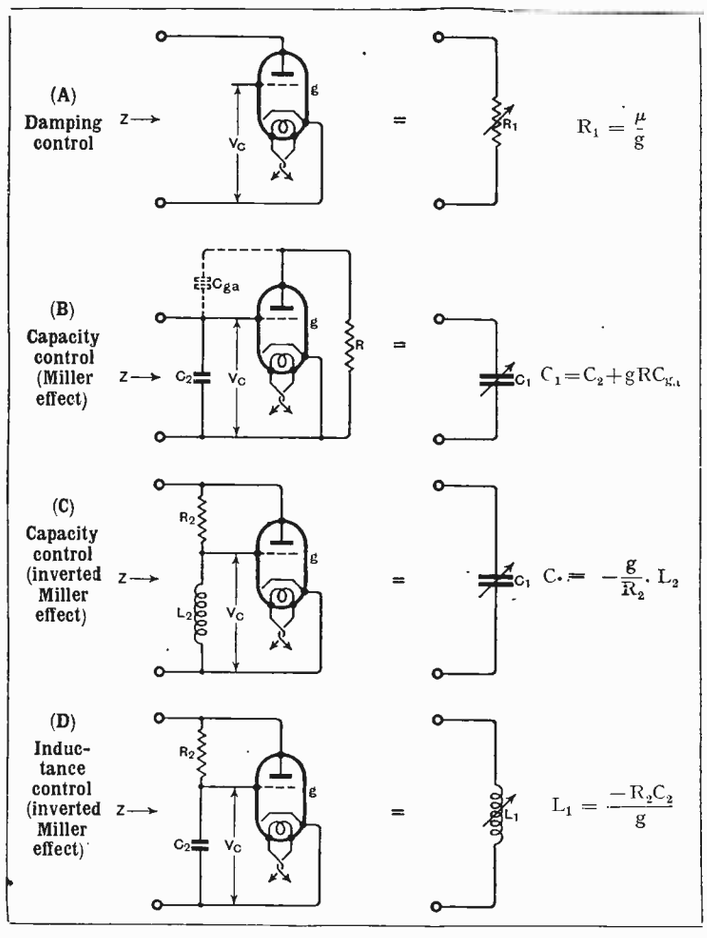

Fig. 3.—Four circuits are shown here which have an input impedance controllable by a bias voltage.

Methods of controlling the oscillator may be resolved into the following types:—

1. **Mechanical control of oscillator frequency.** The direct voltage from the discriminator may be caused to vary the grid bias of a valve and so be converted into corresponding variations in direct current.

This direct current may operate a meter movement in which a vane attached to the pointer constitutes part of the tuning capacity of the oscillator circuit. Alternatively the direct current may operate a relay which in turn starts a motor geared to the oscillator tuning condenser; this principle is used in the Aerodyne "Aeromagic" series of receivers. A third mechanical method consists in varying the oscillator frequency by means of a solenoid-operated plunger of Ferrocart or similar material lowered into the inductance coil of the oscillator; alternatively, the plunger may consist of a "spade" or disc of copper in which eddy currents circulate and so reduce the effective inductance of the coil. In general, the mechanical methods of oscillator frequency control require delicate mechanism which is difficult of adjustment and perhaps not so reliable in operation as the electronic methods which will now be considered.

2. **Electronic methods of oscillator control.** It is possible by different combinations of circuit elements to cause a valve connected in shunt with the oscillator tuned circuit to present an impedance which may be resistive, capacitive or inductive. The exact amount of impedance will depend upon the conductance of the valve, and it is well known that this varies with a change in the grid potential. In the case of a pentode valve the conductance can be similarly changed by varying the voltage applied to the suppressor grid. In Fig. 3 it is shown that by a suitable circuit arrangement it is possible to obtain by means of a valve, an impedance which may be either a resistance, capacitance or inductance, the magnitude of which can be varied by varying the mutual conductance g of the valve. In each case a formula is shown

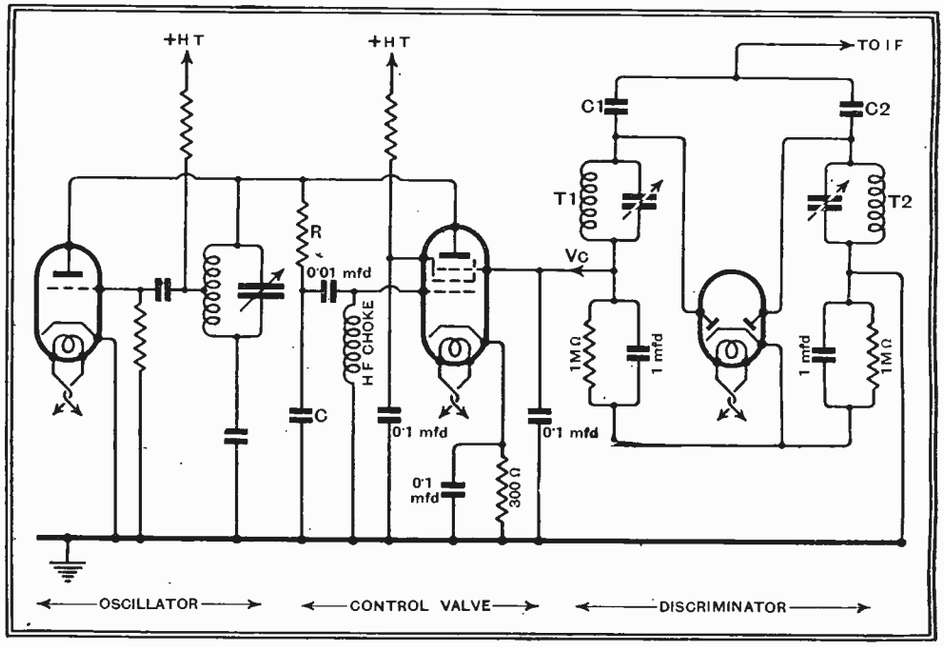

Fig. 4.—The circuit of the oscillator of a superheterodyne with the frequency control valve and discriminator.

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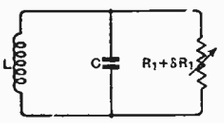
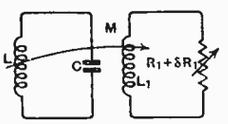
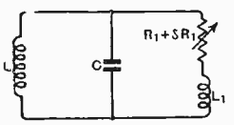
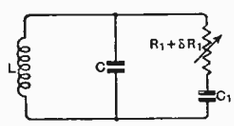
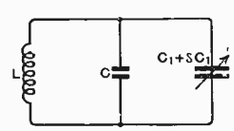
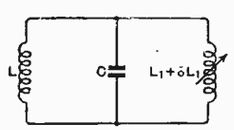
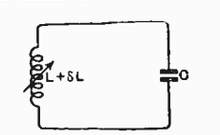
indicating how the value of the equivalent resistance, capacitance or inductance depends upon the valve mutual conductance. The valve is shown as a triode, but there is an inherent assumption in calculating the equivalent impedance that the anode resistance of the valve is large compared with R or R2. Hence, in practice, the control valve will more usually be a screened grid or pentode valve.

The capacity control circuit, using the "Miller" effect shown in B, is a useful method for obtaining a capacity controlled by a direct voltage. It suffers, however, from two disadvantages; the first is that the full value of the oscillator voltage is applied to the grid of the control valve and the capacity change expected from static considerations is not obtained. The second is that the anode resistance R is shunted by the anode - cathode capacity of the control valve and at high frequencies (5 Mc/s and upwards) R ceases to be a resistive impedance and becomes a capacitance and the valve ceases to control effectively. For use at medium frequencies, however, the circuit is quite effective, 5 per cent. changes of frequency at 1 M/cs being easily obtained with little change of damping on the oscillator circuit. Two interesting circuits are shown at C and D in Fig. 3. The principle used is that the voltage applied to the grid of the valve is 90 deg. lagging or leading in phase relative to the voltage across the oscillator tuned circuit. This implies that R2 is large, compared with the grid circuit impedance. When this is so, the impedance Z is a negative inductance when the grid circuit is a capacitance and Z is a negative capacitance when the grid circuit is an inductance.

These circuits have the advantage that since the control-valve anode current is independent of anode voltage (assuming a pentode or screen-grid valve) the control obtained is independent of oscillator amplitude.

The tabulated matter below shows how the control circuits of Fig. 3 may be put to work; formulæ have been developed to indicate how the percentage frequency change $\delta\omega/\omega$ depends on the circuit elements. In practice these formulæ are not exact but serve to indicate how a control circuit may be devised to suit a particular application. In each case shown L and C represent the oscillator tuned circuit, the other variable element being the impedance of the control valve. In general, control circuits giving inductance control produce a constant-percentage frequency change for a given percentage change of direct voltage. Circuits giving capacity control produce a percentage frequency change which varies as the square of the frequency and this is sometimes undesirable. For this reason circuit 6 of the Table and the inductance control circuit D of Fig. 3 are recommended, particularly for high frequencies.

Type of Control.	Circuit.	Fractional Control $\frac{\delta\omega}{\omega}$ in terms of $\frac{\delta R}{R}$ etc.	Control Circuit required (see Fig. 3).	Remarks.
1. Damping (direct).		$\frac{\delta\omega}{\omega} = -\frac{1}{1+\frac{R_1^2}{\omega^2L^2}} \cdot \frac{\delta R_1}{R_1}$	1	To avoid excessive damping $R_1 \gg \omega^2L^2$ and $\frac{\delta\omega}{\omega} = -\frac{\omega^2L^2}{R_1^2} \cdot \frac{\delta R_1}{R_1}$ Proportional to square of frequency. Damping present.
2. Damping (by coupled) circuit).		$\frac{\delta\omega}{\omega} = -\frac{1}{1+\frac{R_1^2}{\omega^2L_1^2}} \cdot \frac{\delta R_1}{R_1}$ $(M^2 = LL_1)$	1	As in 1. $R_1 \gg \omega^2L_1^2$, $\frac{\delta\omega}{\omega} = -\frac{\omega^2L_1^2}{R_1^2} \cdot \frac{\delta R_1}{R_1}$ Damping present.
3. Inductive (by series resistance).		$\frac{\delta\omega}{\omega} = \frac{\omega^2L_1R_1^2L}{[R_1^2+\omega^2L_1^2]^2} \cdot \frac{\delta R_1}{R_1}$ $(L_1 \gg L)$	1	Max. when $R_1 = \omega L_1$ Then $\frac{\delta\omega}{\omega} = \frac{1}{4} \cdot \frac{L}{L_1} \cdot \frac{\delta R_1}{R_1}$ Damping present.
4. Capacitive (by series resistance).		$\frac{\delta\omega}{\omega} = \frac{\omega^4 . R_1^2 . LC_1^3}{[1+\omega^2R_1^2C_1^2]^2} \cdot \frac{\delta R_1}{R_1}$	1	Max. when $R_1 = \frac{1}{\omega C_1}$ Then $\frac{\delta\omega}{\omega} = \frac{1}{4} \cdot \frac{\omega L}{R_1} \cdot \frac{\delta R_1}{R_1}$ Damping present.
5. Capacitative (by shunt capacity).		$\frac{\delta\omega}{\omega} = -\frac{1}{2} \cdot \frac{\delta C_1}{C+C_1} = -\frac{1}{2}\omega^2L\delta C_1$	2 or 3	$\frac{\delta\omega}{\omega}$ is proportional to square of frequency. No damping.
6. Inductive (by shunt inductance).		$\frac{\delta\omega}{\omega} = -\frac{1}{2} \cdot \frac{L}{L+L_1} \cdot \frac{\delta L_1}{L_1}$	4	$\frac{\delta\omega}{\omega}$ constant. No damping.
7. Inductive (direct).		$\frac{\delta\omega}{\omega} = -\frac{1}{2} \cdot \frac{\delta L}{L}$	—	$\frac{\delta\omega}{\omega}$ constant. No damping.

Application of the control circuit to the oscillator tuned circuit.

It should be noted that in all formulæ resistance is in ohms, capacity in farads, inductance in henrys, mutual conductance in amperes per volt, and frequency in cycles per second.

A practical circuit for discriminator and control valve is shown in Fig. 4. The values of R and C are adjusted according to the waverange in use, suitable values being 2,000 ohms and 20 mmfds. at 20 Mc/s, and 10,000 ohms and 50 mmfds. at 1 Mc/s.

It is important that C1 and C2 should be a few mmfds. only since the coupling between T1 and T2 must be quite small.

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T1 and T2 may be the separate halves of an IF transformer of a type similar to that in use in the receiver, each half being tuned to approximately 0.7 of the maximum response but on opposite sides of the resonant frequency. In setting up the circuit it is convenient to heterodyne either a station carrier wave or a signal from a signal generator with an oscillator throwing into the receiver at mid-band intermediate frequency. This discriminator action may then be simulated by applying negative direct voltage to the suppressor grid of the control valve. R and C may then be adjusted so that say 10 kc/s variation in heterodyne beat note is obtained with 0-20 volts variation on the suppressor grid. In order that the oscillator frequency may be controlled in the right direction, i.e., decreased when it is too high and vice versa, it may be necessary to change over the earth and suppressor grid connections to the resistances in the cathode circuit of the diode control valve.

On The Short Waves

NOTES FROM A LISTENER'S LOG

THE large outburst in solar activity during the last week in January, which received so much publicity in the Press, has, unfortunately, been rather short-lived, and, following the marked decrease in the number of visible sunspots during the week ending January 12th, conditions have been poor in the late evenings.

It was perhaps of significance for listeners in this country that the period of good conditions coincided with the flood havoc in the Mississippi and Ohio valleys in the U.S.A., since it enabled many people to obtain first-hand information regarding the various relief measures which were being undertaken and the state of the flooded cities themselves.

Much of this information was obtained from special news transmissions radiated from W2XAD, W3XAL, and W8XK, but there seem to have been a great number of listeners in this country who tuned in to the amateur bands in order to follow the messages being passed by the emergency networks set up by the amateurs.

The effect of the vast yearly "February" peak of sunspot activity was to give almost summer-time conditions on this band during the last week of January and the first in February.

At the moment one is looking forward to another burst at the end of this month.

Readers who operate amateur transmitters may be amused to know that, owing to the heavy rain of the past week, I have had to abandon my twisted-flex feeder, which is matched to the centre of a 66ft. four half-waves 28 Mc/s aerial by means of a quarter-wave matching transformer. The flex when sodden seems to become almost unworkable, and until I am able to replace it with one of more suitable non-hygroscopic material I am using a matching transformer three-quarters of a wavelength long (on 28 Mc/s), which means in my case that only a short flex lead, mostly under cover, is required to join it to the transmitter final tank circuit single-turn coupling coil. The new matching transformer, of course, presents an impedance at the near end similar to that of the old one, but apparently possesses the advantage of also enabling one to work the aerial on 14 Mc/s, at which frequency the open-wire "matching-transformer" is three-eighths of a wavelength long.

On this frequency the impedance of the aerial at the centre is reduced, so that the rise in impedance which takes place on the matching transformer, since it is somewhat longer than a quarter-wave on 14 Mc/s, does not seem to be detrimental.

On 28 Mc/s the horizontal polar diagram of the aerial has four lobes, as in the letter X, and on 14 Mc/s only two, at right angles to the line of the wire, the effective width of the beam in the latter case being ± 34°.

For transmission to New York on 28 Mc/s the wire runs NE and SW, the S end being somewhat lower in order to reduce the radiation-angle of the north-westerly lobe.

This aerial gives good results, but will shortly, it is hoped, be replaced by a more developed array.

It should be noted that the distribution of current in this aerial is not the same as in a "Zepp" of similar dimensions on either frequency.

To deal with conditions during the fortnight under review in more detail, one must note, first, some aerial tests by W3XAL on 17.78 Mc/s on Friday and Saturday, January 29th and 30th. Very little difference was noted between Aerials 1 and 2, but since it was the S. American beam which was undergoing test it is sufficient cause for congratulation that no diminution of strength was noticed on these days.

On Monday, February 1st, conditions were again very good, with W2XAD and W3XAL predominating in the early evening, and with LSX, Buenos Aires, good on 10.35 Mc/s before midnight and W2XAF after.

All frequencies were again excellent on Tuesday, February 2nd, about the peak of the sunspot activity, and the U.S. amateurs on 28 Mc/s were still at good loud speaker strength at 8.30 p.m.

The best 10-metre signals at this time were M1KJJ, of Kennebuck, Maine, and W1IAO, and the 14 Mc/s U.S. amateurs were going strongly at midnight.

The Boston transmitter W1XAL also put up an excellent performance this evening at 11 p.m. on 11.79 Mc/s.

By February 4th, however, the sunspot activity was noticeably falling, and conditions were rather poor in the late evening apart from the S. Americans on 9 and 6 Mc/s.

During the afternoon of February 5th quite a few U.S. apex ultra-high frequency transmitters were heard, W9WAX, a C.B.S. station in Wisconsin, being well received.

Ten-metre conditions, too, seemed to be quite good at 1 p.m. on Saturday, February 6th, and I had no difficulty in chatting to W3FMQ on this band from 1.10 to 1.25 p.m.—quite early for 28 Mc/s transmission to the U.S.A.

In the evening, however, conditions were definitely winter again, although W1XAL was excellent on 11 Mc/s at 9 p.m.

At 2 p.m. on Sunday, too, I had no difficulty in working W1HQN on 28 Mc/s, and discussed various types of transmitting aerials at some length, but conditions were not too good in the evening, although W3XAL on 17.78 Mc/s was satisfactory.

Finally, during the past few days conditions have been anything but good in the late evenings, but then only three small sunspots were visible, so we must wait.

Day-time conditions have, fortunately, been more favourable, and during the fortnight under review it has been possible to receive VK3ME on 9.50 Mc/s, VPD2 Fiji on 9.55 Mc/s, and ZBW3 Hong Kong on 9.525 Mc/s round about noon.

ETHACOMBER.

AMATEUR CO-OPERATION. One of the many amateur stations which have come to the aid of the American authorities by assisting in the relay of messages from the flooded areas. The station shown is at Carrolltown and is being specially used in connection with the organisation of emergency food supplies.

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Current Topics

Danish Broadcasting Reorganised

IT has just been announced in Copenhagen that Mr. Holm, the present Director of Broadcasting, is retiring and that from April 1st a reorganisation of control will take place. There will be four directors controlling, respectively, the financial, musical, literary, and dramatic departments. The financial director will be answerable to the Danish Parliament.

More Sponsored Programmes

THE new buildings of the Radio-Normandie station, which are situated between Rouen and Le Havre, have now been completed, and the apparatus is being installed. The principal studios will be at Caudebec-en-Caux, but the Fécamp studios will still be used for certain programmes.

A Doubtful Compliment for the B.B.C.

A DISCUSSION has been raging in a provincial journal on the other side of the Channel as to whether it is correct for people of strictly religious views to listen to broadcasting during the season of Lent, owing to the frivolous nature of the programmes emanating from most stations. There have been many arguments put forward both for and against Lenten listening, but the battle has been finally settled by a correspondent who, by one of those flashes of genius which most of us experience at some time in our lives, has suggested that a compromise be made by listening only to the transmissions from England during that period.

N.B.C. Programmes for Europe

IT is reported that the new SW directional aerial erected by the N.B.C. for transmitting programmes to Europe will be inaugurated to-morrow (February 20th) with programmes in French, Italian, and German. President Roosevelt is expected to make a speech in English and French. The N.B.C. and also the C.B.S. already have directional aerials in action for supplying programmes to South America, and these are used very extensively. Apart from programmes in Spanish which are specially prepared for South American listeners, the U.S. broadcasting authorities have made arrangements to transmit a large number of the ordinary programmes. These will be picked up and relayed by land stations in the Argentine and elsewhere, and in return certain South American programmes will be picked up and broadcast in the U.S.A.

WIRELESS TO THE RESCUE.

Radio has once more proved its great value in a National emergency when other means of communication have been cut off. Apart from the invaluable work done by amateurs in the recent floods in the Ohio and Mississipi valleys, the National Broadcasting Co. of America has done yeoman service in this direction. Rowing boats and cars have been equipped with small trans-receivers working on ultra-short-wave lengths and weighing only 5 lbs. apiece. By these means the cars and boats have been able to receive wireless instructions from the aeroplanes surveying the scene of the disaster, and to proceed direct to the points where they were most needed. In addition, these radio-equipped boats have been useful in enabling eye-witness accounts to be given of the work of rescue.

An Embarrassing Situation

IT seems to be the unwritten law in Germany nowadays that anybody possessing a wireless set must extend hospitality to less fortunate neighbours on occasions when important public announcements are being broadcast by a Government speaker. A correspondent informs us that on a recent occasion of this kind a flat-dweller had to accommodate no fewer than fifteen persons who were gathered in by the caretaker of the block of flats who happened to be on bad terms with this particular tenant.

French Static-monger Fined

THE Correctional Tribunal of Chateau-Gentier, which more or less corresponds to the Petty Sessional Court in this country, has just inflicted a ten-franc fine on a shopkeeper for selling an electric fan without taking the necessary steps to see that it did not cause interference to broadcasting. The fan caused severe trouble to many listeners who complained. The nuisance continued, however, and after investigation the vendor of the apparatus was brought to justice. The Court was extremely interested in the explanation given by the prosecution of the manner in which the interference from the fan was measured to see whether or not it exceeded the legal limit.

Sound-proof Walls

IT is reported from Denmark that Professor Larsen has just discovered the ideal sound-proofing material for broadcast studios and for the rooms of listeners in semi-detached houses whose enjoyment of broadcasting is spoilt when the loud speaker from next door is reproducing some other programme. The sound-proofing material is said to consist of a layer of asphalt covered with metal, and so it seems that it is neither inexpensive nor convenient.

Wireless on Trains

THE Turkish Foreign Minister has been lamenting the lack of telephonic facilities on trains. On many occasions, he states, when on long journeys he has felt the lack of this refinement of civilisation. Experiments have, of course, been conducted with a view to fitting trains with a telephony service, and in one instance telephonic communication was carried out between a train in the U.S.A. and another in Germany, both being in motion at the time. It is thought, however, that the amount of patronage available for a universal train telephony service would not justify the expense. A large number of American and European trains are, of course, fitted with wireless receivers for the reception of broadcasting programmes.

A Noteworthy Jubilee

THE most famous as well as the loftiest wireless mast in the world is undoubtedly the Eiffel Tower, which is nearly a thousand feet (300 metres) high. The Eiffel Tower was one of the earliest land stations in the world, and during the war its time signals and news service were invaluable to ships at sea, since, even with a crystal or magnetic detector, its signals could, in favourable circumstances, be heard well over a thousand miles away. It was, too, one of the earliest broadcasting stations. This famous mast was begun in 1887, soon after Hertz's experimental confirmation of Clerk Maxwell's mathematical work in connection with electro-magnetic waves, but its use for wireless purposes was not, of course, envisaged at that date.

Marconi Wireless School

THE next session at the Marconi School of Wireless Communication at Chelmsford commences on March 1st. The school, which is under the guidance of Mr. H. M. Dowsett, M.I.E.E., F.Inst.P., receives students for post-graduate courses in wireless communication. Full details are available from Marconi's Wireless Telegraph Co., Ltd., Electra House, Victoria Embankment, London, W.C.2.

I.W.T. Lecture

AT the February meeting of the London Section of the Institute of Wireless Technology, which was held last Wednesday (February 17th), Dr. N. W. McLachlan lectured on the Reproduction of Transients and Higher Harmonics in Loud Speakers.

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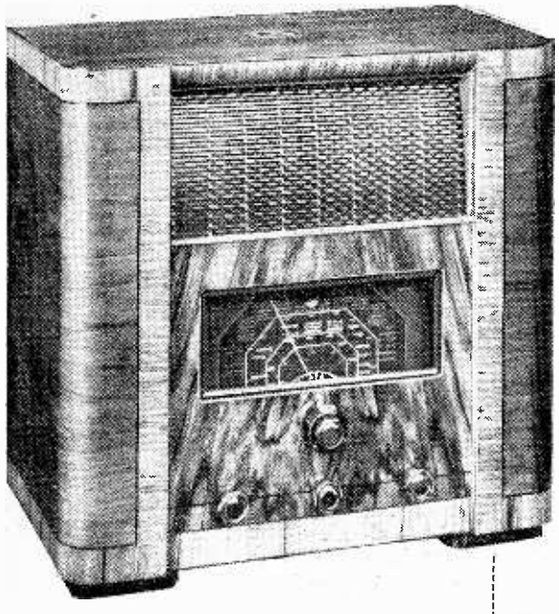


H.M.V. MODEL 482

EFFICIENT ALL-ROUND PERFORMANCE INCLUDING RECEPTION OF SHORT WAVES

FEATURES.—***Type.***—*Table model superheterodyne for AC mains.* ***Wave-ranges.***—*(1) 16.5-51.5 metres. (2) 200-580 metres. (3) 725-2,000 metres.* ***Circuit.***—*Var.-mu pentode RF amplifier—heptode frequency-changer — var.-mu pentode IF amplifier — diode second detector— triode first AF amplifier — pentode output valve. Full-wave valve rectifier.* ***Controls.***—*(1) Tuning. (2) Volume. (3) Tone. (4) Wave-range. (5) Radio-gramo. switch. (6) Mains on-off switch.* ***Price.***—*16 guineas.* ***Makers.***—*The Gramophone Co., Ltd., 98/108, Clerkenwell, London, E.C.1.*

IN the range of H.M.V. "All-World" receivers, comprising thirteen models, this set occupies a position between the multi-range sets capable of receiving television sound and the less expensive receivers with a single short-wave range. In common with the latter sets it has a short-wave band covering 16.5 to just over 50 metres, but in this case a stage of RF amplification is included which considerably increases the range and selectivity on all wavebands.

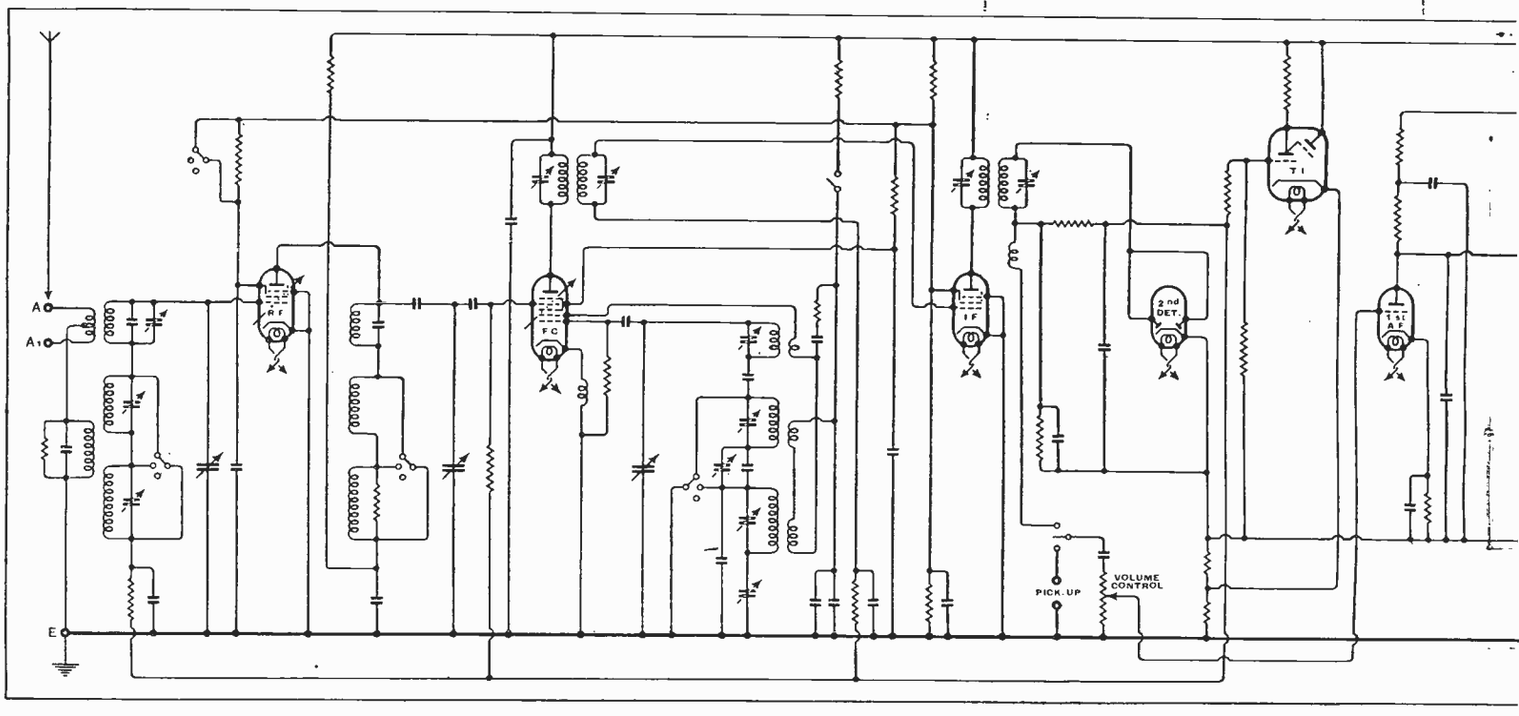
The set is housed in a walnut cabinet of simple and practical design in which the loud speaker is mounted near the top behind a bronzed metal grille. The rectangular tuning scale is exceptionally easy to read, and carries names of over eighty stations on the medium-wave band, which is coloured in green. The white long-wave scale also carries station names, but the red short-wave band is marked only with the regions where broadcast transmissions are usually received.

It would be impracticable to give station settings on the short-wave range, so a subsidiary vernier scale is provided which virtually lengthens the tuning dial and enables notes to be taken of station settings for future reference. A tuning indicator of the cathode-ray type is viewed through a semicircular window near the top of the dial, which concentrates the attention on a pair of segments and is an improvement on the usual arrangement where all four segments are seen at the same time.

Other interesting points in the specification are the provision of a tone control which simultaneously varies the bass and treble response, a small but efficient loud speaker giving more than usually good quality, and a mains transformer covering the wide range of 95 to 260 volts. The set is designed for use with aerials of the doublet or anti-interference type, and the circuit is so arranged that the aerial operates as an ordinary "T" type on medium and long waves without the necessity for switching. A normal single-wire aerial can be used if desired.

The first valve is an RF amplifier of the variable-mu pentode type, which is tuned-

Complete circuit diagram. The aerial circuit is designed for use with single-wire, doublet or anti-interference aerials. Special attention has been given to the question of oscillator drift in designing the frequency-changer circuits.



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anode coupled to a heptode frequency-changer. Certain deviations from standard practice will be noticed in the connections of this stage, and in all cases these modifications are directed to improve frequency stability in the oscillator section. The single IF amplifier is a variable-mu pentode functioning at a frequency of 465 kc/s. The output IF transformer feeds a double-diode second detector in which the anodes are connected in parallel. AVC is derived from this valve through an efficient filtering system, and the cathode-ray tuning indicator is controlled from the AVC line in the usual way.

First stage AF amplification is provided by a triode, and the volume control in the grid circuit is effective for both radio and gramophone reproduction. The radio-gramo. switch, incidentally, is mounted at the back of the set, separate from the waverange switch. Resistance coupling is employed between the first AF amplifier and the pentode output valve.

Maintaining Tonal Balance

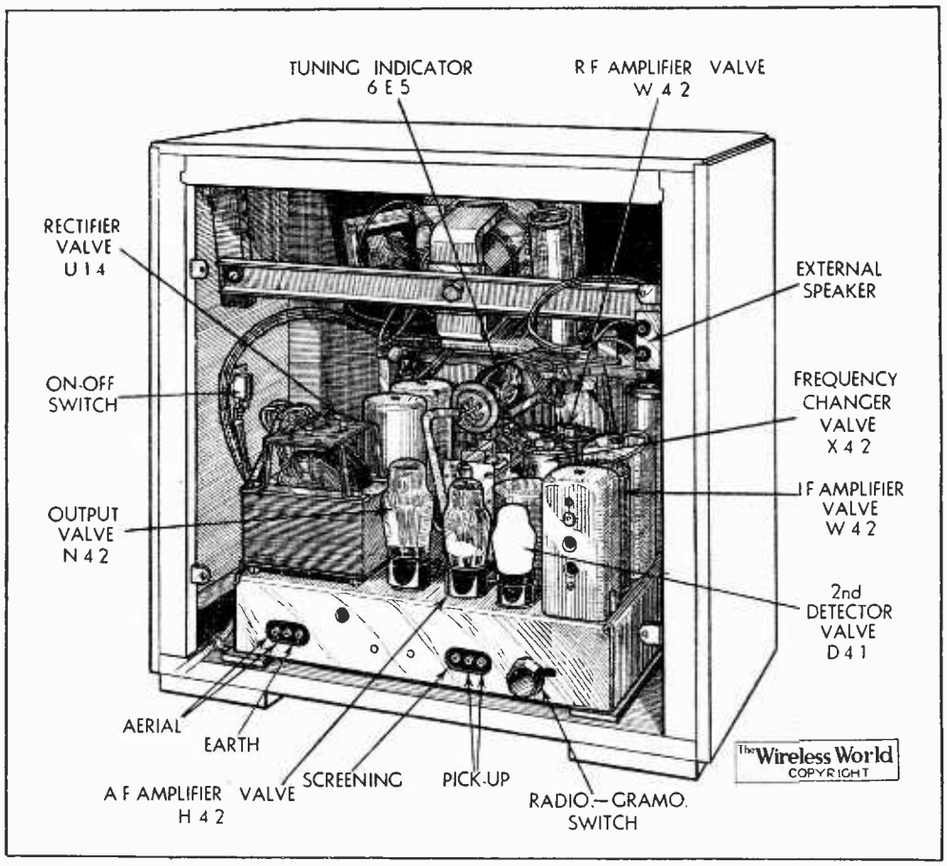
Tone control is effected by a six-position switch with two sets of contacts. High-note response is progressively reduced by connecting additional condensers across the primary winding of the output transformer, and in the two positions of lowest tone the coupling condenser from the first AF stage is reduced in value in order to avoid a preponderance of bass when receiving conditions compel the high-note response to be reduced to the lowest possible level.

Under normal conditions on the medium- and long-wave ranges the full top response can be used, and on the short-wave band the conditions are rarely bad enough to call for a reduction of top equivalent to more than one or two studs of the tone control. The surprising thing is that provided the station is accurately tuned by reference to the tuning indicator, it is virtually impossible to produce unpleasant quality from the loud speaker, and when proper attention is given to the adjustment of the tone control in relation to the volume level, really first-class quality is obtained. The reproduction is of a round, full-bodied type, with plenty of depth for the development of every gradation of tone, and it is something of an achievement to have obtained such a fine bass response from so small a loud speaker without any obvious reliance on resonances. The cabinet is strongly made, and the loud speaker assembly is held rigidly by a channel-section metal bar across the full width of the cabinet.

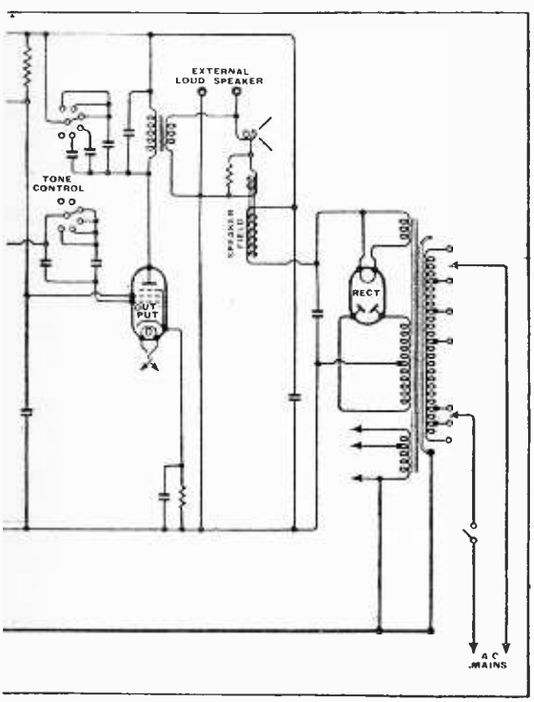
Whatever the dial setting may be when one first switches over to the short-wave band, it will be apparent that the sensitivity is of an unusually high order, and one will naturally hurry to the wavelengths of American broadcasting to see how these familiar stations come in. Judging from the results we obtained on W3XAL, 16.87 metres, and W2XAD, 19.57 metres, we are confident that the user's first opinions will be amply confirmed. For a period of several hours during the afternoon both these stations came through steadily at full loud speaker strength with only two-thirds of the volume control in use, and with a steadiness which testified to the efficiency of the AVC system. Incidentally, the tuning indicator is more than usually responsive to these distant stations without showing signs of overloading on the powerful locals on the medium-wave band.

About fifteen foreign programmes were well received during the hours of daylight on the medium-wave band, and the selectivity was sufficient to give clear reception outside one channel on either side of the settings of the two Brookmans Park stations. Both on medium and long waves the reception was quite free from second-channel interference whistles, and on the long-wave band the selectivity was such that the Deutschlandsender could be ranked with the other high-power Continental stations from the point of view of programme value. In this respect the performance was outstandingly good, yet the selectivity which it implies does not appear to have had any adverse effect on the quality from Droitwich.

The set is turned out with the customary H.M.V. attention to clean workmanship in the chassis and high-grade finish in the cabinet. It is, in our opinion, a set which is representative from every point of view of the way in which a receiver should be designed to give the maximum entertainment value—good appearance, reproduction of a quality worth listening to for its own sake, liveliness of performance with adequate selectivity, and no loose ends such as unsuppressed self-generated whistles.



A separate switch for changing from radio to gramophone reproduction is mounted at the back of the chassis. Note the mounting of the energised moving-coil loud speaker, which, although small, is of efficient design, particularly from the point of view of bass response.



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The Television Receiver

II.—IF or VF Amplification?

By W. T. COCKING

THE manner in which amplification is to be obtained is discussed in this article. The questions of straight set versus superheterodyne and of pre-detector versus post-detector amplification are treated in some detail.

THE requirements for a television receiver were outlined in Part I, and we must now consider how they are best obtained in practice. In the pre-detector circuits we can use either straight RF amplification or the superheterodyne, and in the post-detector circuits we are offered the choice of a direct feed to the CR tube or the use of vision-frequency amplification. Incidentally, the term vision-frequency (abbreviated VF) will be used to denote the range of detector output frequencies corresponding to the transmitter modulation with exactly the same meaning as low-frequency or audio-frequency is used in a sound receiver. The change is made because it is obviously absurd to speak of low frequencies when they extend up to 2 Mc/s or so.

From the point of view of securing the necessary amplification with the minimum number of valves, a straight set with two RF stages, a detector, and two or three VF stages is the best. Experience shows, however, that it is hardly possible to secure adequate selectivity with the necessary band-width with the few tuned circuits appertaining to such a receiver, that the DC component in the detector output cannot readily be retained, and that it is difficult to secure satisfactory separation of the synchronising impulses.

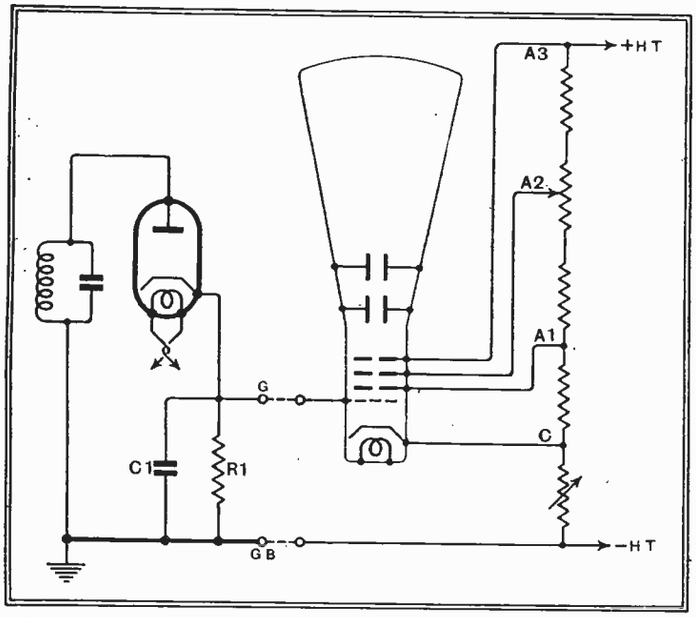

Fig. 2.—The connections between a diode detector and a CR tube when the DC component of the detector output is retained are shown here.

These last two points will greatly affect our design of receiver, and they are consequently worth discussing in some detail before we consider the other alternatives. Before we can consider the pre-detector circuits it is necessary to decide whether or not it is advisable to employ VF amplification, and, if so, how much.

The total output of the receiver must be some 30 volts peak-to-peak. We can, if we desire, obtain this directly from a diode detector, connecting the tube directly across the diode load resistance as shown in Fig. 2. This illustration also shows the CR tube and the way in which its various potentials are derived from a supply of 3,000 - 6,000 volts. The necessary by-pass condensers are, however, omitted. The diode load resistance R1 must be of low value—5,000-10,000 ohms—if the high modulation frequencies are not to be attenuated, and for the same reason the by-pass condenser C1 must be kept small—usually about 10 $\mu\mu$F.

A low-impedance diode must consequently be used, but in spite of this the detector efficiency is likely to be poor, and to secure an output of 30 volts p-p the peak RF or IF input may have to be as much as 40-60 volts. This may lead to difficulties in obtaining such an output from the preceding valve, but on the other hand there is ample RF or IF voltage available for operating the sync separator already described.[1]

It should particularly be noted in Fig 2 that the CR tube is fed directly from the detector without any isolating condenser. This means that the frequency-response extends down to zero and the DC detector output is applied to the tube, with the result that the mean brilliancy of the picture corresponds with that of the transmitted scene.

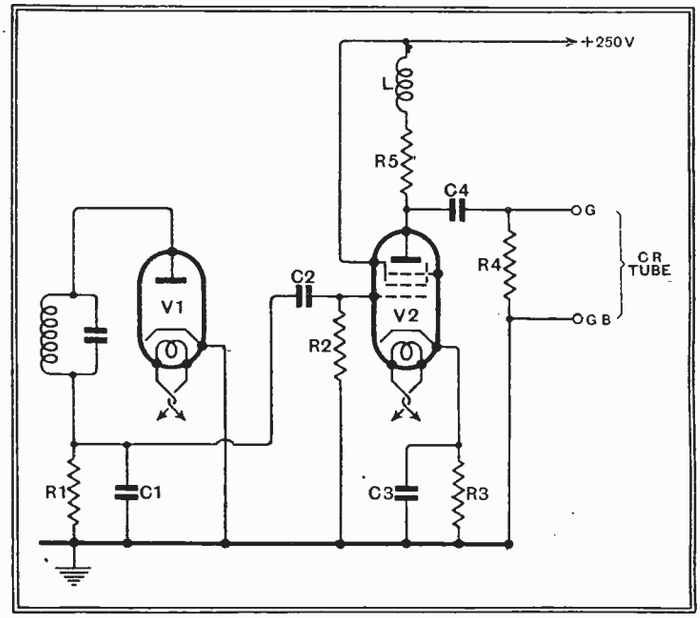

Fig. 3.—A stage of VF amplification can be used following the detector. Owing to the coupling condensers C2 and C4 the DC component is not retained.

If the DC component is not retained, as when a coupling condenser and grid leak are included, only changes of brilliancy recurring more frequently than some ten times a second can be passed. This means that a change in the mean illumination at the transmitter is not passed on to the tube, and also that large evenly illuminated areas may become somewhat patchy. It is, therefore, desirable to retain the DC component.

A single VF stage using a modern pentode such as the N43 will give a gain of from 25 to 35 times, with a response curve varying by only 2 or 3 db. from 20 c/s to 1.5 Mc/s when used in the circuit of Fig. 3. In order to transmit low frequencies without attenuation, C2 and C4 must be of very large capacity, and their associated

[1] *The Wireless World*, January 22nd, 1937

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The Television Receiver—

resistances R2 and R4 of high value in accordance with the usual laws governing resistance-capacity coupling. Moreover, C3 must have a low reactance at low frequencies compared with R3; as R3 is of the order of 100 ohms, C3 must be about 500 μF. If C3 is not large enough, negative feed-back will seriously reduce the bass response.

At high frequencies the response depends upon the correct proportioning of the values of the coupling components. For a given frequency response there are optimum values of R5 and L assuming a definite figure for the stray circuit capacities. In the limit, therefore, the amplification possible depends on the stray capacities, and to secure maximum gain they must be kept as low as possible. The relationship of these values has already been treated,[2] and will be dealt with again in relation to IF amplifiers, for this coupling has an important application in certain types of IF amplifier.

Since one stage of this type gives a gain of the order of 30 times, the detector output will be only about 1 volt p-p and its input something like 1.5-3 volts peak. Now the sync separator described requires an input of at least 10 volts peak (100 per cent. modulation) for proper operation, so that it cannot be used with this arrangement. The sync pulses must consequently be separated from the vision signal in the output of the VF amplifier, unless the sync separator is provided with an extra IF stage of its own to provide the necessary input. This hardly seems economical, however.

Now an attempt to separate the sync pulses from the output of the VF stage usually fails because, although the amplitude is adequate, the absence of the DC component means that the amplitude of the sync pulses relative to the fixed bias of this valve is continually changing with variations in the picture content. Because of this it is difficult to secure constant amplitude of sync pulses in the output of the separator and the time-bases consequently run irregularly.

The position is considerably eased if the DC component is retained, and with only a single VF stage this is quite possible. The connections are shown in Fig. 4, and since the detector output voltage is always negative with respect to its no-signal value the VF amplifier must, in the absence of a signal, be biased just beyond the point at which grid current flows. This is a value of bias considerably below the normal. In the output the values of R4 and R5 must be adjusted so that the potential of the junction is equal to the no-signal

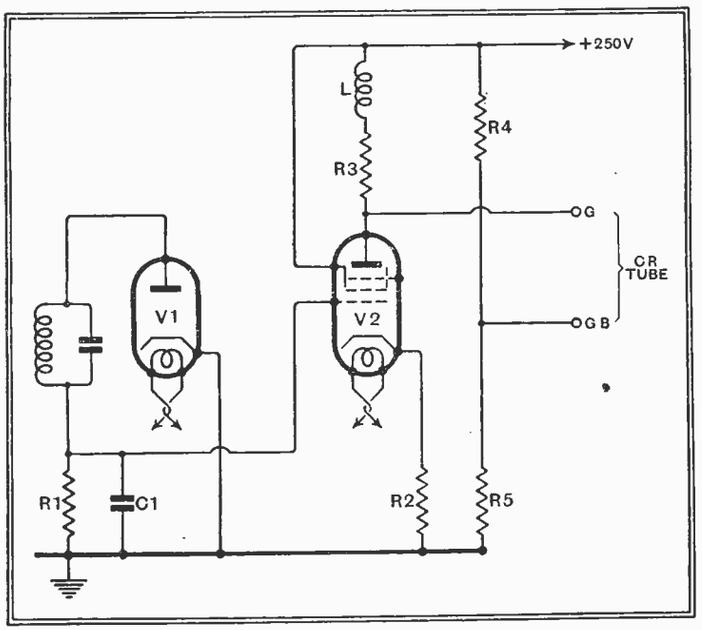


Fig. 4.—By adopting direct coupling in the manner shown here the DC component can be kept at its proper amplitude even when VF amplification is used.

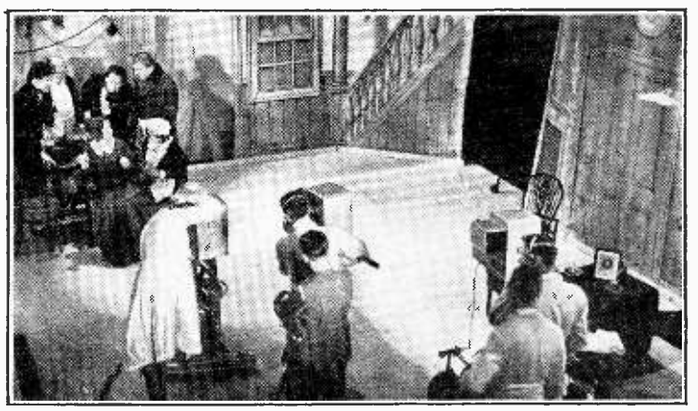
anode voltage of V2. When this is done the steady anode voltage does not appear across the output terminals.

Since the amplifier functions at zero frequency, decoupling cannot be included nor can the bias resistance be by-passed. Negative feed-back must be tolerated at all frequencies, therefore, and reduces the gain to the region of 20 times. The detector output will thus be some 1.5 volts p-p, and the input of the order of 2-4.5 volts peak. It is still too small for the operation of an amplitude filter, and the sync pulses must be separated from the vision signals in the output circuit.

Because there is a fixed point of reference this is easier than when there is no DC component, but there are still certain difficulties, chief among which is the desirability of a direct coupling to the sync separator. It can be done, however. Practical experience with this circuit reveals several difficulties which can all be traced to the DC amplification. It is easy to see that the no-signal bias of V2 is not merely the voltage across R2 but in addition the small voltage across R1 due to the anode current of V1. As this varies with different valves, the bias of R2 varies, and hence its anode potential, by something like 20 times the amount. In practice, variations in the no-signal anode potential of V2 of the order of 10 volts are encountered, and, as this point must be used as the point of reference for sync separation, balancing adjustments must be provided to enable the correct conditions to be secured. Any change in the no-signal anode voltage of V2 is likely to upset the sync separator, and such changes will also occur through mains voltage fluctuations and through alterations in the setting of the sensitivity control unless the regulation of the mains equipment is exceptionally good.

It is the writer's view, therefore, based on practical experience, that it is advisable to avoid the use of vision-frequency amplification wherever possible. This does not, of course, mean that such stages cannot be used successfully, but that in his experience it is easier to secure the required performance without such amplification.

Having thus decided to obtain all the amplification before the detector, we have to choose between the straight set and the superheterodyne. To obtain the requisite amplification at radio-frequency demands at least six stages, and, bearing in mind the high frequency of 45.0 Mc/s, the difficulty of maintaining stability can easily be seen. A similar number of stages is likely to be needed in a superheterodyne, but because of the lower frequency stability is easier to maintain, the performance is less likely to be affected by small changes in circuit values and wiring, and the measurement of the amplifier is considerably simplified. Furthermore, the amplification can be split so that some is obtained at radio and some at intermediate frequency, with considerable benefit to stability.



TELEVISION STUDIO SCENE.

The "still" camera overlooks the roving eye of the television cameras during the taking of a scene in the Alexandra Palace studios. The set for another "shot" is seen on the right.

[2] *The Wireless World*, April 26th, and May 3rd, 1935.

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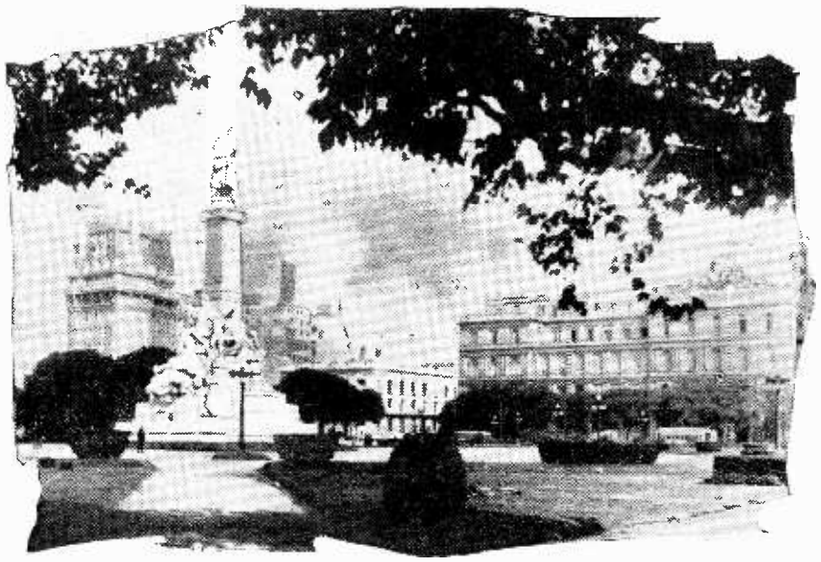
Listeners' Guide



THE GOVERNMENT HOUSE, right, and the monument to Christopher Columbus in the Plaza Colon, at Buenos Aires, whence the second inter-continental concert will be broadcast.

ARGENTINA provides the second inter-continental concert, which will be broadcast on Sunday at 4 by many foreign stations as well as by the London Regional. It has been arranged by the Argentine Association of Broadcasters in collaboration with the U.I.R. The programme will commence with the chiming of the historic "Independence Bell" in the Cabildo Building, Buenos Aires, then follows a prologue given in Spanish, English, French and German. The announcement which precedes each item will also be made in these four languages. Although limited to half an hour it is the desire of the Argentine Broadcasters to give listeners, by varied and multiple features, a programme of typical national music, and at the same time paint a colourful picture of the life and customs of the Argentine people.

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BEFORE YOU HEAR IT

THE second programme in the "In the Making" series comes to Regional listeners on Thursday at 9.40. This time the Music Hall programmes are dealt with. Listeners will be let into some of the secrets which lie behind the scenes in the process of compiling the programmes for the fifty-two Music Hall shows which are given in St. George's Hall during the year. It will be produced by John Cheatle with the co-operation of John Sharman, producer of Music Hall.

John Sharman, by the way, was last Sunday initiated into the Grand Order of Water Rats. This Order has been described as "The Freemasonry of the Music Hall and Variety Stage," and its 120 members, all men, comprise in the main the stars of variety.

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"I WAS THERE"

A SECOND edition of this popular series of talks begins to-night, and five weekly programmes will be included on subsequent Fridays. The first talk at 9.20 (Nat.) will be given by C. F. Elwell, M.I.E.E., who, as most of our readers will know, is a radio-engineering pioneer. He was present at the appalling earthquake and fire that caused widespread havoc in San Francisco in 1906. At that time he was at college in San Francisco, and the particular building in which he was sleeping was razed to the ground. He was training as an electrical technician, and was able to help in the mammoth task of producing order out of chaos by helping to get the tramway system reorganised.

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SONGS FROM THE FILMS

So insistent have been the demands for repetition that, although John Watt had decided to postpone its re-introduction, the Variety Department has been forced to the conclusion that "Songs from the Films" should be given a place in the programmes at once. Gracie Fields will inaugurate the first of the new series, and she is collaborating with John Watt in the presentation of numbers from her own films. A very popular series of films have been chosen by John Watt from which to pick his winners. Among them are "Follow the Fleet," "Sanders of the River" and "Flying Down to Rio."

Details of the week's Television programmes will be found on p. 176.

In the cast of this first edition, which will be broadcast to-night at 8 (Nat.) and on Saturday at 6 (Reg.), will be Eda Peel, Reginald Purdell, Foster Richardson, Sam Browne, the Three Ginx and the B.B.C. Revue Chorus.

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FIGURES OF FICTION

ONE of Walter de la Mare's most charming short stories, "Henry Brocken," has been turned into a play for broadcasting by Patrick Riddell, the successful adaptor of Dumas' "Twenty Years After." It recounts the adventures of a young man, a lover of books, who escapes from mundane life into an enchanted world which is inhabited by those great figures who live for ever in the pages of the masterpieces of fiction.

The production of this charming fantasy, to be broadcast at 9.30 (Nat.) on Sunday, will be in the hands of Barbara Burnham. Special music has been composed by Dr. C. Armstrong Gibbs, who is a close friend of Walter de la Mare and has written music for many of the latter's poems.

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"KERBSIDE KABARET"

THE programme with this title originated from an argument that the genuine talent in the streets of London was equal to that presented in many forms of public entertainment. B. Martin Marks, who supported the affirmative in this argument, has been a keen listener to London's street performers, and will present "Kerbside Kabaret" to Regional listeners to-night (Friday) at 7.40. The compère will be chosen from the scores of high-speed vendors that abound in the city streets, and in introducing the artistes he will describe them and tell where they were found.

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POPULATION

A SERIES of broadcasts on world population, which will be heard each Tuesday until March 23rd, commences this week. The first will take the form of a debate entitled "Room for Expansion" and will be on the subject of the small family, its causes and consequences. T. H. Marshall, Reader in Sociology, Economics, and Political Science at London University, will pre-

VIENNESE PIANISTS. Maryan Rawicz and Walter Landauer the well-known pianists who will give another of their two-piano broadcasts on Tuesday.

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Outstanding Broadcasts at Home and Abroad for the Week

side, and it is probable that such diverse characters as a recently married mill girl, a clerk earning £350 per annum, and an unemployed miner will be brought to the microphone to join in the debate. National listeners will hear this at 9.20.

VIENNA

THE seventieth anniversary of the first performance of one of the most famous pieces of music in the world, Strauss' "Blue Danube," is being celebrated in Vienna and by broadcasts from many European stations. To-night (Fri.) at 9 (Reg.), Felix Felton will produce a commemorative programme written by Igor Vinogradoff to mark the occasion. It will consist of a radio-dramatic survey of the events of the years in Vienna preceding the composing of the famous waltz. It was to the inhabitants of Vienna that the composer dedicated the waltz to console them for their defeat at Königratz during the Austro-Prussian War of 1866-7.

MUSIC

FRITZ REINER will be the guest conductor at the Sunday Orchestral Concert this week which will be given at 6.30 (Reg.). The programme will consist entirely of Wagner, including excerpts from "Siegfried," "Das Rheingold," and "Götterdämmerung." The soloists will be Walter Widdop and Florence Austral. Fritz Reiner was at one time conductor of the Dresden Opera and has been working in recent years in America, where he is now Director of the Philadelphia Opera.

The B.B.C. Symphony Orchestra in the Queen's Hall on Wednesday will also be in charge of a guest conductor, Ernest Ansermet. The concert will be broadcast at 8.15 and 9.30 (Nat.). Lionel Tertis, who celebrated his sixtieth birthday last December, will be the soloist in William Walton's Viola Concerto and Berlioz' "Harold in Italy."

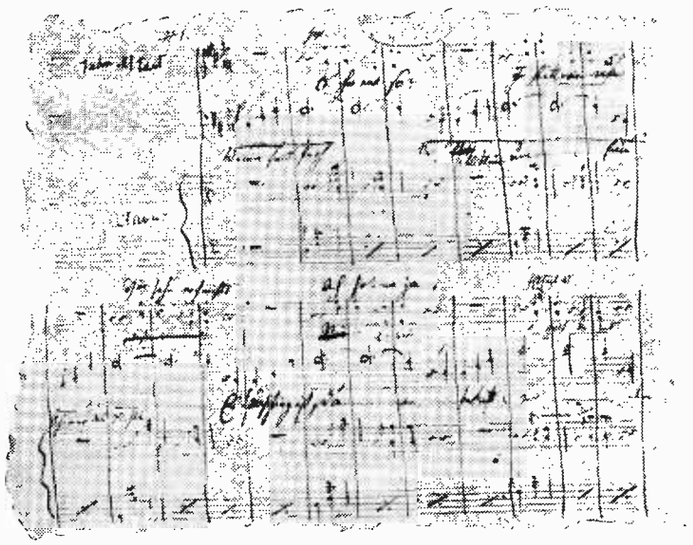
STEEL

THE B.B.C.'s mobile recording unit recently spent a busy week in Sheffield taking recordings at various big steel works for use in a feature programme called "Steel," arranged by D. G. Bridson in collaboration with Desmond McMahon, to be broadcast on Tuesday at 8.10 (Reg.) Dr. McMahon, who is musical adviser to the Manchester Educational authorities, has composed a special overture with the same title which is to be performed under his direction by the Northern Orchestra at 8, immediately preceding the programme proper. Music will be an integral part of the feature programme, which has been conceived as a symphony in four movements. Narratory sequences backed by appropriate effects and linked by music will give listeners a vivid picture of the whole industry.

OPERA

THE week opens with a relay by Warsaw from the Opera, Verdi's "Aïda" being billed for 7.10. It is most interesting to recall that this opera enjoyed the unique experience of an open-air performance at the foot of the Pyramids on March 3rd, 1912. The first act of this opera will also be heard by National listeners at 2.30 on Saturday, when it will be relayed from Sadler's Wells.

Paris PTT gives us the pleasure of hearing the 8.30 programme from the Opéra-Comique on Saturday, when Bizet's immortal "Carmen" will be produced. The première of this opera at the Paris Opéra-Comique in 1875 was a tragedy, for the Parisiens, still smarting over the war of 1870 and the siege of Paris, saw only a symbol of brutality in Bizet's vigorous music. They received it with "great impatience," and Bizet left the opera house a broken man, retiring to his bed and dying within three months at the early age of thirty-seven.



THE BLUE DANUBE. Part of Strauss' original score for the famous waltz which is featured in a special Regional programme to-night.

Milan 1 also gives us the pleasure of a Royal Opera relay on Saturday, this time from the Rome Opera House, where, at 8, Cilea's "L'Arlesiana" (The Maid of Arles) will be given.

Beethoven's one and only opera, "Fidelio," with its delightful music and romantic setting in mediæval Spain, will be heard from Stuttgart at 6.40 on Sunday and again on Tuesday from Brussels 1 at 8.25.

"HORST WESSEL"

MOST German stations on Tuesday are devoting special programmes to the National-Socialist hero, Horst Wessel, whose name is linked with the German National Anthem. He died on February 23rd, 1930, and Deutschlandsender at 7.10 gives a special commemorative broadcast.

THE AUDITOR.

HIGHLIGHTS OF THE WEEK

FRIDAY, FEBRUARY 19th.

Nat., 6.25, Welsh Folk Songs: B.B.C. Singers (A). 8, "Songs from the Films." 9.20, "I Was There." 9.40, Contemporary Music Concert.
Reg., 6, Orchestre Raymonde and Carmen del Rio. 7.40, "Kerbside Kabaret." 9, Feature Programme. "The Blue Danube."
Abroad.
Warsaw, 7.10, "Aïda" (Verdi) from the Grand Theatre.

SATURDAY, FEBRUARY 20th.

Nat., 2.30, Act 1 of "Aïda" from Sadler's Wells. 9.20, Gilbert and Sullivan selections: B.B.C. Military Band.
Reg., 6, "Songs from the Films." 8, "Young Roscius": the life of the boy actor, William Henry Betty.
Abroad.
Frankfurt, 7.10, Skiers' Gala from the Hotel Schneeberg.

SUNDAY, FEBRUARY 21st.

Nat., 5.20, The Isolde Menges String Quartet. 7.55, Roman Catholic Service from St. Dominic's Priory, Hampstead 9.30, "Henry Brocken."
Reg., 4, Relay of Argentine Concert. 5, Famous Trials—11. 9.5, B.B.C. Theatre Orchestra and Garda Hall.
Abroad.
Strasbourg, 8.15, "Carmen" (Bizet) relayed from the Municipal Theatre, Metz.

MONDAY, FEBRUARY 22nd.

Nat., 6.40, Music from the Movies. 7.20, Entertainment Parade. ¶It's Happening Now.
Reg., 6, Commentary on Fashion Parade at the B.I.F. 8.30 "Lovely Women and Ugly Men."
Abroad.
Leipzig, 7.10, Johann Strauss Concert: The Leipzig Symphony Orchestra.

TUESDAY, FEBRUARY 23rd.

Nat., 6.25, Dale Smith and Sterndale Bennett in Songs for Two. ¶"Lovely Women and Ugly Men." 9.20, Discussion: "Room for Expansion."
Reg., 7.30, Rawicz and Landauer: two pianos. 8.10, "Steel": feature programme.
Abroad.
Deutschlandsender, 7.10, "Horst Wessel."

WEDNESDAY, FEBRUARY 24th.

Nat., 7.45, Van Phillips and his two orchestras. 8.15, and 9.30, Symphony Concert from the Queen's Hall.
Reg., 7.45, The World Goes By. 8.15, Carroll Levis and his Discoveries—5.
Abroad.
Deutschlandsender, 8.15, "An Evening with Franz von Blom, the composer of military music."

THURSDAY, FEBRUARY 25th.

Nat., 6.20, This Way Out: John Hilton. 7.15, "Beauty Queen," Radio Play.
Reg., 6, International Staff Band of the Salvation Army. ¶Reid Orchestral Concert. 9.40, In the Making—2.
Abroad.
Leipzig, 6.30, Concert from the Gewandhaus.

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Transmission Lines

SOME FURTHER NOTES

By M. G. SCROGGIE, B.Sc., A.M.I.E.E.

THE subject of transmission lines —which have for years been much used in commercial practice and are now finding considerable application to amateur and domestic radio—is a very extensive one and opens up many new ideas to those whose knowledge of circuits has hitherto been confined to "lumped" inductances and capacities. The necessarily rather compressed explanation given a few weeks ago[1] leaves some points that perhaps are not quite clear.

For example, after describing the characteristic impedance of a transmission line as the resistance of the load which it can be used to supply with maximum efficiency, I went on to include this matching or equalisation of the impedances of line and load within the well-known law for any two pieces of electrical apparatus that are related as generator and load (such, for instance, as a valve and loud speaker). A correspondent considers that as in the latter case the theoretical efficiency when maximum output is obtained is 50 per cent the same might be supposed to be true of the transmission line. It would, of course, be very unsatisfactory if 50 per cent. of the output power of a transmitter were wasted in the feeder line before it reached the aerial! The 50 per cent. applies when, as in the example of a valve, the impedance of the generator is entirely in the form of resistance. When the impedance of the generator is entirely devoid of resistance the efficiency is theoretically 100 per cent. The resistance of a properly designed line is so low that the loss is only a few per cent. or perhaps less than one decibel. If the losses in the line are *not* relatively small the simple formula for characteristic impedance (designated Zo), $\sqrt{\frac{l}{c}}$ ceases to apply. It ought, perhaps, to be mentioned that l and c must be in consistent units, such as microhenrys and microfarads.

Explaining the Aerial Feeder

A more serious misunderstanding is the failure to distinguish this matched-impedance method of operating a line from the use of it as an acceptor or rejector circuit, or as a tuned feeder. Unfortunately a statement in the earlier article that it is necessary to make the feeder of exactly the right length was misplaced and appeared to refer to the matched-impedance feeder. Actually it refers to the tuned type of feeder, and to anyone who was misled I apologise and hope now to make the position clear.

If a line consisting of a pair of parallel wires or tubes is imagined to extend away from the source of power to an infinite length, then any alternating voltage generated by the source starts a wave that just goes on and on. Unless the losses are absolutely nil the wave gradually gets weaker. But it never arrives.

All real things, good or bad, do come to an end; and if the line stops short, without anything into which it can deliver its message, the wave starts back home again—is *reflected*. If conditions at the starting end are similar it is reflected there too, and keeps on going backwards and forwards until the losses of the line have dissipated it. Certain special conditions exist when the line is a whole number of quarter-wavelengths long, because then the waves surging to and fro combine in a regular fashion to give points of maximum and minimum current and voltage at fixed points along the route; in other words, *standing waves*. When this happens, the line is equivalent to a resonant tuned circuit; whether acceptor or rejector depends on the number of quarter-wavelengths and whether the end is open or short-circuited.

If there is a load of some sort at the far end it absorbs at least part of the power of the wave, but unless the ratio of voltage to current at that point in the line agrees with the impedance of the load the balance of power is reflected and standing waves still exist.

These are the conditions under which, if it is to be used as an aerial feeder, a line must be adjusted to the correct length. Half a wavelength is the most usual. Fig. 2 (a) illustrates a half-wave dipole aerial fed at the centre by a tuned half-wave feeder. Remember that the tuning in this case consists in the choice of length, not in condenser adjustment.

As conditions repeat themselves every half wavelength, a test for correctness is that it should be possible to add or remove a half-wave section entirely without producing a theoretically wrong circuit. Remove the line then, and feed the aerial direct. The centre of such an aerial is a point of maximum current, so it would be useless to feed it by a *parallel* resonant circuit, or rejector, as in Fig. 2 (b). That produces volts but not much current externally. A *series* circuit is necessary (2(c)). In practice two condensers are usually adopted to balance the system.

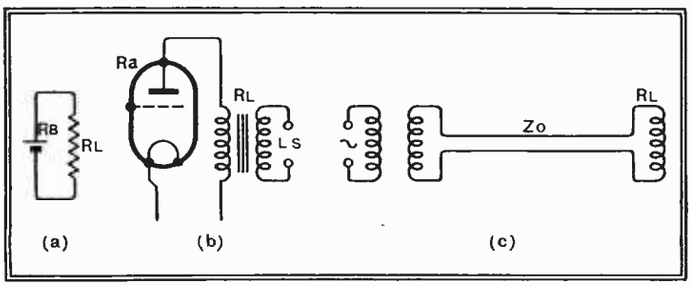

Fig. 1 (a).—The maximum output is obtained from a battery when the load resistance RL is made equal to the battery internal resistance RB. The efficiency is then only 50 per cent. This condition is not aimed at in practice—except perhaps in car starting! The same principle governs other forms of electrical generators such as dynamos or valves (b). Here again, although the *maximum* output is obtained from a valve when its internal resistance Ra and the load resistance RL are equal, for other reasons RL is usually made considerably larger. A line (c) feeding a load has an impedance Zo which is preferably almost resistanceless. The loss is therefore very small even when maximum output is being delivered, so one generally aims at matching RL and Zo numerically.

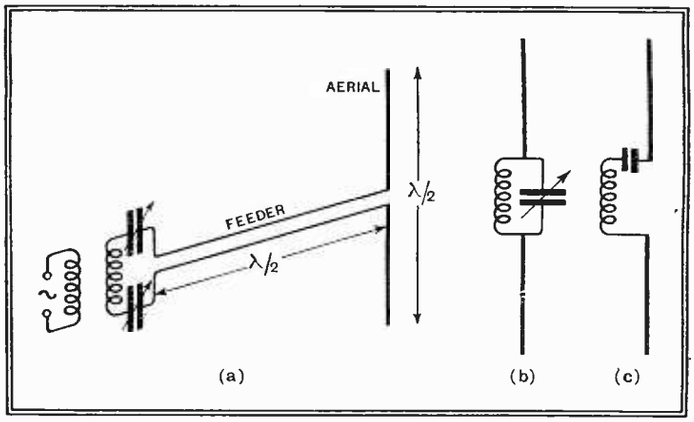

Fig. 2.—As the electrical conditions repeat themselves every half-wavelength, a system (a) consisting of an aerial fed from a coupling coil through a line can be simplified for purposes of study by omitting the line and coupling direct to the aerial. Voltage drive by a parallel resonant circuit, (b), is unsuitable at the centre of the aerial, where *current* is at maximum. A series circuit (c), is correct.

[1] January 8th, 1937

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Transmission Lines—

An alternative is to feed the aerial at the end, which is a point of maximum voltage—see Fig. 3. If the feeder is still half a wavelength long a parallel input circuit is necessary; but one has the option of current-feeding the line and transforming to voltage (to put it rather crudely) at the aerial end, by making the line $\frac{1}{4}$, $\frac{3}{4}$, $\frac{5}{4}$, etc., wavelength.

An aerial fed right at the centre or right at the end presents a load of much lower or much higher impedance than the line. So the two are not matched, and in order to obtain satisfactory results it is necessary for the length of the line to be correctly adjusted. Owing to the very large circulating currents the line must be very low in resistance if the losses are not to be prohibitive. So lines of twisted flex or of many wavelengths are unsuitable for tuned operation. Over a distance such as half a short or ultra-short wavelength the system is quite useful and is rather easier for the amateur to adjust than the matched feeder. Moreover, it is practicable to excite the aerial at harmonics as well as the fundamental.

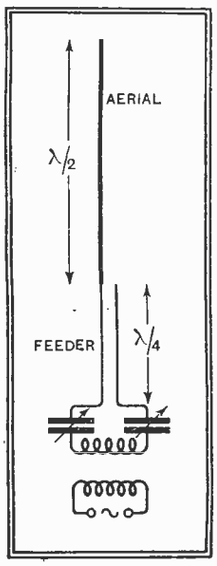

Fig. 3.—Alternatively, the aerial may be voltage-driven at one end by a series circuit if a quarter-wave length of line is included in the feeder.

A line is matched when the load is of the correct impedance to accept all the power that travels down it. The load, in fact, is equivalent to an infinitely long extension of the line, "from which no traveller returns." Then there is no reflected wave, no standing waves, and no maxima and minima of current and voltage. Apart from a progressive decline due to losses, the alternating current and voltage are the same throughout the length. In fact, that is the basis of a common method of detecting when a line is correctly matched. It is no longer essential—for receiving aerials, at any rate—to use air-spaced wires or tubes; various insulated cables are on the market, and these can be used to link up an aerial many wavelengths away without prohibitive loss. The characteristic impedance of such lines has to be measured and is specified by the makers; but air-spaced lines can be calculated, and curves for reading off the impedance were given in the previous article, which also explained how matching can be done by means of transformers.

When the load is an aerial it is more usual to use a divergent tapping (Fig. 4). The impedance of the aerial between two taps close together at the centre is, as already mentioned, very low; and towards the extremities very high. Somewhere between is a pair of points giving the correct matching connection for any given line. Each different combination has to be individually worked out.

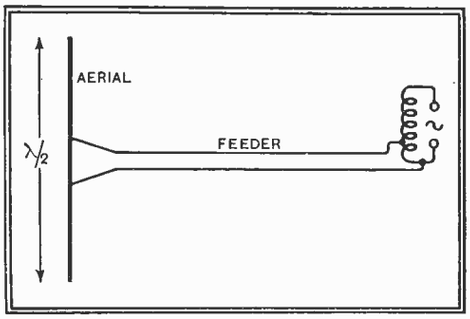

Fig. 4.—If an impedance-matched feeder is used the line may be any convenient length, but the end connections are important. Here is the usual method at the aerial end—a divergent tapping of the correct dimensions. The other end is tapped the appropriate distance up the tuned circuit coil, or a variable coupling is used.

The circuits at each end of the line—oscillator and aerial in the case of a transmitting system—are fixed resistive impedances only at the one working wavelength; it is impossible to maintain proper matching over a band of wavelengths. The various anti-interference aerials now on sale for working over two or more wavebands are provided with matching transformers that constitute as good a compromise as the designer can devise. The loss is generally much greater than could be tolerated in a transmitter, but in a receiver the loss is endured fairly cheerfully if noise is reduced in a substantially larger ratio.

Finally, it may be of interest to mention how a quarter-wave line may be used as a very easily constructed matching transformer to connect two systems having different impedances. If Z_1 is the impedance to which one end of a quarter-wave line is equivalent when an impedance Z_2 is connected to the other end, then $Z_1 = \frac{Z_{02}}{Z_2}$. So if it is desired to join two circuits or lines of impedances, Z_1 and Z_2 respectively, a quarter-wave line with a characteristic impedance (Z_0) equal to $\sqrt{Z_1 Z_2}$ may be employed as the link. If you

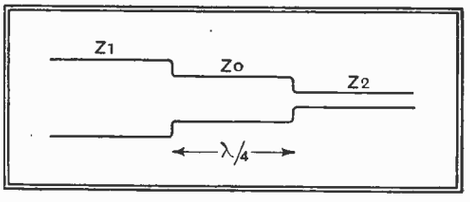

Fig. 5.—A convenient alternative to the usual type of transformer for connecting two systems of different impedance is a quarter-wave line having a characteristic impedance which is the geometric mean of the other two ($Z^2 = Z_1 Z_2$).

substitute $\sqrt{Z_1 Z_2}$ for Z_0 in the first equation you will see that the Z_1 end of the line presents an impedance equal to Z_1, and the Z_2 end presents an impedance Z_2, so both ends are matched at once. Rather a cunning scheme!

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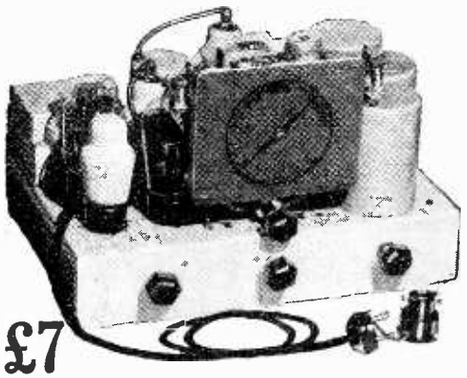

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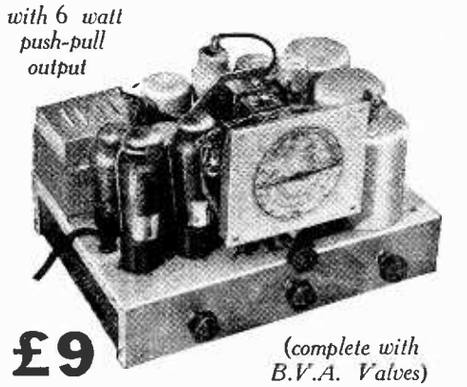

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BROADCAST BREVITIES

NEWS FROM PORTLAND PLACE

Rumours in Great Portland Street

A SLEUTH saw building operations in progress at 63, Great Portland Street: and there was born the rumour of a new super music-hall for the B.B.C.

It was a good rumour—not so very far from the truth—but the truth about the music-hall had nothing in common with 63, Great Portland Street.

Backing on St. George's

What is happening in the street of motor cars is that the new building backing on to St. George's Hall will be partly occupied by B.B.C. offices associated with the Variety department's home of entertainment. Actually four floors will be taken over by the Corporation, while the ground floor will presumably be used as a car showroom.

B.B.C.'s Super Music Hall

It ought to be mentioned that the B.B.C. is not looking for a site for a large-scale music-hall, because one has already been found. The construction of the hall will be part of the big building programme scheduled for 1937-8. Who the architect will be is not yet decided; but it is certain that the B.B.C.'s new Home of Terpsichore will stand in startling contrast to its Georgian surroundings.

For a short time it may be used concurrently with St. George's Hall, the lease of which runs for another five years.

Suitable for Television?

In all probability the architect will so plan the building that it can be used for television. None of the existing sound studios is at all suitable for television work, which demands ample height to ensure adequate lighting effects as well as far more ventilation than obtains in any of the existing studios in Broadcasting House. Most of these, also, have too long a reverberation period; television, with its numerous "props," lighting standards, and metal-bodied cameras, requires more acoustic deadness.

Basement for Celebrities

This factor will be taken into account in the design of the television "celebrity studio," which, by the way, is to be located underground in the new Broadcasting House extension. There is a precedent for this, as the early 30-line tests were conducted from Studio BA, which is in the "B.H." basement.

Fun, But No Leg-Pulling

FELIX FELTON, who has been entrusted with the production of a feature programme on April 1st, promises that there will be no leg-pulling. His aim will be to scour the country for ancient customs associated with All Fools' Day; but instead of bringing his characters to the studio, he will arrange a country-wide hook-up, as the Americans put it, in co-operation with the "O.B." Department.

Monarch Of All

It is not generally realised, perhaps, that a B.B.C. producer is vested with extraordinary authority so far as his own productions are concerned. If he wishes it, he can enlist the services of a small army of departments, from the "O.B." men to the guardians of the boiler house. Needless to say, he always secures the most willing co-operation; if he decides to "put over" a speech by Oliver Cromwell, or an excerpt from an American Presidential address, the Library leaps to his aid. If he wants blue lights and soft music, the electricians and the Music Department will trip over each other in their efforts to supply the necessary.

This sounds idyllic, but it is true.

PRODUCERS AT PLAY. Felix Felton pays close attention to Miss Cynthia Pughe, with Max Kester holding a "watching brief," during a performance last week by the B.B.C. Dramatic Society when they produced A. A. Milne's play "The Fourth Wall."

Easter

LIVERPOOL Cathedral organ —the biggest of its kind in existence—will be heard in the Easter morning broadcast on March 28th. The Dean will preach. The evening service comes from Ripon Cathedral.

The Good Friday concert, broadcast from Queen's Hall, will consist of "Parsifal," with the B.B.C. Symphony Orchestra conducted by Sir Henry Wood.

Two "star" items for Easter Monday will be one of Geraldo's famous "Music Shop" programmes, and another version of "Flying High," the racy R.A.F. variety show produced by Charles Brewer.

In the afternoon the O.B. microphones will eavesdrop on racing at Brooklands.

Coronation Broadcasts

FOUR hours of almost continuous broadcasting of the Coronation ceremony and of incidents relating to it are promised for May 12th. Mr. Cecil Graves, Controller of Programmes, is already devoting most of his time to preparing plans.

What he has in mind is that the period from 10.15 a.m. to 2.0 p.m. approximately will be occupied with the Procession to the Abbey and the Coronation Service itself. At two o'clock there will be a short interval, and the commentary will be resumed when the head of the Procession reaches Constitution Hill on its way back to Buckingham Palace. Some fifty microphones will be used, including three "effects" microphones at Trafalgar Square, St. James's Palace and Oxford Circus.

Seven O.B. Points

There will be seven observers engaged on descriptive accounts, the first in the precincts of Buckingham Palace, the second on the corner between Constitution Hill and the Mall, the third at the Cenotaph, the fourth outside the Abbey, the fifth in the Annexe, the sixth inside the Abbey, the seventh at Constitution Hill.

Abbey Control Room

A central control will be established in Westminster Abbey, with thirty circuits coming in from other points. Here the mixing will be done before the transmission is passed on by landline to Broadcasting House. There will be at least ten foreign observers outside Westminster Abbey with their own observation boxes and their own control points. Observers so far selected for the B.B.C.'s broadcast are Messrs. Howard Marshall, John Snagge, T. Woodrooffe and George Blake.

Feature Programmes

Other special broadcasts have been sketched out for Coronation week; the following may be mentioned:—

A talk on the religious significance of the Coronation Ceremony, by Laurence Tanner (May 9th); a Children's feature programme, "The King's Chair" (May 9th).

"The King's Anointing," a programme dealing with the historical significance of the Coronation (May 9th); "The Empire's Homage," a programme contributed by the Empire and culminating at about 8.0 p.m. with a broadcast by the King (Coronation Day); "Coronation Carnival," a recorded summary of the week's celebrations throughout the country (May 15th); "In Town To-night," a twenty-minute programme to be broadcast nightly, bringing to the microphone personalities of every description present in town for the Coronation celebrations.

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Letters to the Editor

The Editor does not hold himself responsible for the opinions of his correspondents.

Negative Feed-back Detector

YOUR paper is to be congratulated on introducing a new form of anode bend detection. Having already got amplified AVC of the kind which requires positive feed, as shown in *The Wireless World*[1] some time ago, and which itself works admirably, I resolved to lose no time in trying the new detector. Contrary to what I expected, there was no difficulty in linking it up with the AVC, the only alteration necessary being an increased resistance in the bias portion of AVC potential. No tapping on detector load is required in my case to feed AVC valve. I find the best all-round results are obtained with 125,000 ohms load resistance and usual choke filter between it and cathode. The valve used is an ancient but O.K. Mullard 354. There is no question about the better quality on deeply modulated transmissions, and night distortion is also lessened, or so I think.

Now, what are we to call it? Anti-bend or negative bend? What we quality fans now want is some means of counteracting unequal fading of carrier and side bands, also a practical means of avoiding side-band twitter without losing high notes.

Torquay. G. F. C. BUNTING.

Short-wave Aerials

I FIND that I (and many others, for that matter) have fallen into an error of nomenclature in referring to half-wave low-voltage fed aerials as "dipoles" and their centre-fed equivalents as "doublets."

A Hertzian dipole appears to be defined as "a small element of current separated by opposite charges," and the classical theory of electro-magnetic radiation is built upon this basis in which the dipole is considered as a pair of spheres carrying equal but instantaneously opposite alternating charges, and connected together by a fine short element of wire.

If the capacity of the wire is considered small compared with the spheres, the current distribution through the wire is substantially uniform. Half-wave aerials used for television and short-wave reception are characterised by their departure from uniform current distribution, and it may only be said that a very short element at the centre of such an aerial would comprise a dipole.

Turning now to the use of the word "doublet," it appears that any two charges separated by any distance constitute a doublet, whether connected by a wire or not. Their effect upon a distant point will produce a moment QX where Q is the charge and X their distance apart.

Hence neither "dipole" nor "doublet" define the half-wave aerial, but are merely terms referring to certain arrangements of currents and charges on a basis of forming classical theories of electromagnetic radiation. I have been in touch with certain responsible physicists who agree that half-wave aerials are ill defined by those who apply the terms "dipole" and "doublet," and that they (the physicists) merely refer to them as "half-wave vertical or horizontal aerials." They are to be considered voltage fed or terminated when a feeder is connected to one end, and as current fed when a feeder is disposed at the centre.

May I respectfully suggest that the Editor permits correspondence on this matter in the way of comments and suggestions?

F. R. W. STRAFFORD,
Chief Research Engineer,
Belling and Lee, Ltd.

[1] "New Detector Circuit," *The Wireless World*, January 1st, 1937.

The Radio Industry

RADIO components, measuring instruments and precision machined parts and assemblies are being shown at the B.I.F. (Stand No. A81, Olympia) by Wright and Weaire, Ltd.

◈ ◈ ◈ ◈

The Director of the City of Leicester Municipal Library (Bishop Street, Leicester) is forming a collection of manufacturers' catalogues. Firms are invited to supply a complete set of their current publications, which will be indexed in the card catalogue, both under the firm's name and the particular productions in which they specialise.

◈ ◈ ◈ ◈

In a published statement on the television position, Scophony, Ltd., welcomes the adoption of a uniform standard by the B.B.C., though without expressing an opinion as to what the final standard should be. Scophony has always aimed at the production of receivers with large screens, and recent experiences have strengthened the firm's opinion on this matter.

◈ ◈ ◈ ◈

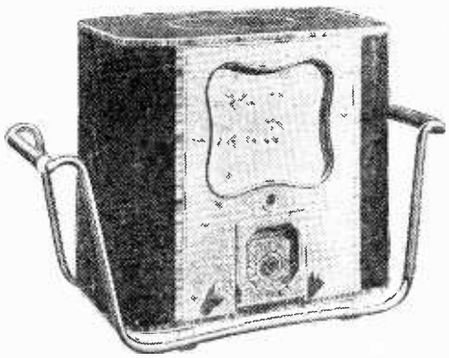
Synthetic resins are now being applied to the manufacture of optical "glassware" by a moulding process developed by Combined Optical Industries, Ltd., 21, Denmark Street, London, W.C.2. Mirror drums and other optical systems used in television can be produced economically in quantities, and it is stated that the material takes silvering satisfactorily.

◈ ◈ ◈ ◈

We understand that the price of the Goodman's 12in. Auditorium Reproducer, *without stand*, is £7 13s.

◈ ◈ ◈ ◈

Applications for the Supreme Instruments Corporation's free manual on testing instruments (mentioned last week) should be addressed to the firm at Greenwood, Mississippi, U.S.A., and not to this office.



FOR ORIENTAL LISTENERS. This photograph shows one of a number of Philips receivers specially built for H.H. the Maharajah of Patiala. To suit the customs of the country, where the listeners sit on carpets or cushions instead of chairs, the sets are mounted on castors at a height suitable for floor-level listening. The models are distinctly "de luxe," with real ivory knobs, etc.

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WE'VE all heard those "famous last words"—all except the fellow most intimately concerned. He has to pay for his fame. Unfortunately, in your business your customer has the last word .... and YOU PAY! He's not worried when he switches on with the wrong transformer tapping used—he's got your guarantee, and he will still be there to claim. Have the last word yourself—you can if you fit T.C.C. Wet Electrolytics. However careless your customer, high voltage surges just cannot pass—and are kept within safe limits—so are your SERVICE COSTS.

●

FOUR TYPICAL TYPES

Type	Capacity	Continuous Working Volts
802	16 mfds.	440 volts Peak
602	8 mfds.	440 volts Peak
805	8 mfds.	500 volts Peak
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UNBIASED

By FREE GRID

An Alarming Prospect

I TRUST that you will excuse any feelings of irritability which may make themselves manifest in these notes this week, but I am, at the moment, feeling far from comfortable either physically or mentally and, as somebody or other once remarked, no man can give of his best when he is in this state. My discomfort is caused by the fact that I am nearly frozen and, in addition, suffering from eye-strain owing to the fact that I am writing these few notes by the light and heat of a guttering candle stuck into the fireplace, as both the electric fire and the lights are cold, dark and lifeless.

The reason for my being bereft of light and heat is not, as some of the less kindly of you may think, that the electricity supply has been cut off owing to my not paying the bill, but, on the contrary, it is due to my very meticulousness in religiously obeying all the electricity companies' rules and regulations. This evening I had the misfortune to blow the company's sealed fuses, and although there are those who are sufficiently low in their moral standards to break the seals and replace the fuses themselves to save their having to wait in cold and darkness

"By the light of a guttering candle."

until the company's men arrive, my conscience will not allow me to commit this deliberate offence against the regulations. I therefore attempted to pick up a live connection by jabbing a couple of hatpins into the mains on the sunny side of the fuse boxes. Unfortunately something must have gone wrong with my aim, as one of my hatpins transfixed both mains simultaneously and upset some substation, for the whole street seems to be in the same predicament as myself, and there appear to be the makings of a first-class riot outside my residence.

What is troubling me, however, is the fact that this incident has brought home to me very forcibly the truth of the statement which some irresponsible journalist has been making in the daily press to the effect that in the event of an air raid the enemy would probably bomb the power stations. At the time, I remember, I thought little of it except that in many ways it might prove a blessing if it happened during one of the B.B.C.'s moral uplift programmes, but to-night's happenings have shown me clearly the seriousness of the whole situation, as the programme was cut off in the middle of the football results and, judging by the tumult outside, I am not the only one who is prevented from checking his pool coupons.

I would, therefore, most strongly urge all of you to follow my example to resolve to obtain a battery set as a standby, a resolution which I intend to carry out the first thing on Monday morning. If my words are not heeded, I can see a still greater disaster overtaking humanity if the enemy should be so inconsiderate and unmannerly as to make a raid when the racing results are being announced.

With regard to the particular type of set I intend to obtain, it will certainly be a portable one, as probably we shall have to finish the checking of our pool coupons and bookmakers' slips while wending our way to the local gas shelter, and for this reason I am having a pair of headphones built into my gas mask.

The B.B.C.'s Secret Service Department

THE old saying about all being fair in love and war is, I suppose, quite true and so I have no reason to grumble, but all the same, I cannot help feeling very sore about the dirty trick which has been served me by the B.B.C.—for I can think of no other explanation about certain recent events.

I had arrived home on the night of the B.B.C.'s broadcast of the 1922 Scrapbook, and was all ready armed with notebook and pencil to make my customary check on its historical accuracy—or rather, lack of it—when the telephone bell rang. A very old friend who was passing through London on his way from Southend to Spitzbergen desired to see me on urgent business. Like a fool, I swallowed the tale, but the worst was yet to come. On the following night, when the programme was to be repeated, I received an urgent call purporting to come from the police, informing me that a much-bemonied aunt had been run over by a motor bus, and that she was asking for me. Needless to say, I crammed on my hat and, jumping into a taxi, I bade the driver to emulate the example of Jehu.

"Making himself agreeable to the servants."

I suppose really that it is my own fault for not being more wideawake, for certain mysterious happenings in my locality some weeks ago ought to have put me wise to the fact that my movements were being tracked by the B.B.C.'s confidential agents, and that a dossier of my private life was being compiled by their Intelligence Department to see if they could not find some private scandal in it to use as a lever for persuading me to keep a civil tongue in my head—or, perhaps I should say, a more discreet pen in my hand.

In the first place, after the warnings which came from the daily press, I should have realised that my telephone calls to certain paid spies of my own at Broadcasting House were probably being tapped. What really ought to have put me on my guard, however, was the appearance of a mysterious personage, apparently of the tramp class, who was loafing about for some considerable time in the vicinity of my residence in January.

The presence of this individual was first brought to my notice by Mrs. Free Grid, who reported to me that a man with a badly battered bowler and no seat to his trousers, had been hanging about in the vicinity, soliciting alms and trying to play Chamber Music on a tin whistle. This, in itself, should have put me on my guard, for genuine street musicians of this class usually prefer to give a recital of music of the "Nelly Dean" class rather than Chamber Music. When I heard, however, that this individual had been making himself agreeable to the servants in the pseudo-Oxford accent which is almost *de rigeur* at Broadcasting House, I should have immediately woken up to what was afoot.

I can only ascribe my denseness to the stultifying effect of a new method of cookery which Mrs. Free Grid has adopted lately as a result of reading a book recommended in one of the B.B.C.'s broadcast talks—a fact which, in itself, is significant.

Anyhow, whatever be the true explanation of my thick-headedness, I certainly did not tumble to the plot, and the result has been the missing of the programme. Still, I suppose it is no use crying over spilt milk. My telephone calls to Broadcasting House are now all spoken in code.

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Random Radiations

By "DIALLIST"

British-made "American" Valves

ONE British valve manufacturer has already announced a fairly extensive range of American-type valves, and others are sure to follow suit—probably further announcements will have been made by the time that you read this. It had been known for a week or two that something of the kind was in the wind, and there was a good deal of speculation as to the idea behind it all. Presumably, it's an attempt to kill two birds with one stone: (1) to capture a fair share of the valve replacement market offered by the American sets in use in this country and (2) to compete with the American valve in various parts of the Empire. Both are praiseworthy objectives and everyone must hope that they'll be achieved.

Why Not a Bold Step?

That we must tackle the American valve there can't be any doubt when you look at the figures. It is estimated that there are 1,500,000 American receiving sets in use here. Last year we imported over 2,000,000 valves from the U.S.A., and goodness knows how many were sold in the Empire. I can't pretend to be a business man, but it seems to me that the only way to meet American competition is for us to produce valves as good, if not better, at something near the same price.

The thing that would give wireless as a hobby one of the biggest boosts that it has ever had would be the adoption of one much reduced price for *all* except the very complicated types of mains valves, and one price, again much reduced, for *all* normal types of battery valves. If manufacturers could but bring themselves to take that plunge, the results might be spectacular. And, in any event, would it not be better for them to do so while the going, if I may so put it, is good? If we are now making American types with 6.3-volt heaters, what is to prevent American concerns from making British types with 4-volt heaters?

What Would Happen

You, dear reader, know as well as I do that any amount of people are deterred from buying sets containing more than 3 or 4 valves because they fear the possible cost of replacements. Manufacturers complain that the valve replacement market is very small. Can you wonder—can they wonder—that it is when the cost of fitting new valves may far exceed the second-hand or part-exchange value of the set? If valve prices came right down our set makers might well adopt the policy of some American firms and make the price of the receiver include a complete outfit of spare valves. This alone would mean increased sales of several millions a year, and *wouldn't* it be a selling point for sets? Whether that could be done or not, reduced valve prices would enormously increase the market for big sets and give our designers a chance of showing what they really can do. Television would be helped, too, for if the possible replacement of 4 or 5 valves at present prices is a bogy that frightens many purchasers of broadcast receivers, what about anything up to a couple of dozen in a television set?

All Clear For Television

NOW that we are guaranteed that there shall be only one system of television transmission, and that no changes will take place before the end of next year at the earliest, television has its chance to go right ahead. Besides adding slightly to the complexity (and therefore the cost) of receiving apparatus, the use of two quite different methods very much hampered the programme people at the Alexandra Palace. Each system needed its own production technique, its own lighting, and even its own make-up for artists. There are only two big studios, and they, like the transmitting plants, were used turn about week by week. With only one system in use, both studios will be available at all times, and there will be far more elbow room all round. Programme builders, when thinking ahead, won't have to ponder whether a particular item is suitable for a particular system; they can concentrate now on bringing out to the full the latent possibilities of the one that remains.

Cheaper Viewing

WITH the price of television receivers down by one-third, and taking into account the promised spectacles and festivities, the number in private hands should increase pretty rapidly between now and the middle of May. When you come to think of it, 80 gns. is not out of the way for a television receiver which is combined with a "sound" receiver covering wavelengths from 7 to 2,000 metres. A good deal more than this is willingly paid for radiograms by those in search of the best possible quality in reproduction. It now seems likely that one of the London "sound" programmes will be sent out on the ultra-short waveband, and if this is done the purchaser of a television set will be able to rely on quality that is unobtainable on the longer waves. This alone should be a big attraction. Another point which will carry weight is that the price of the sound and vision receiver covers free installation (including the special aerial) and free maintenance for a whole year from the date of purchase.

Radio P.T.

THE B.B.C., I observe, is to co-operate with the Government in its efforts to make us physically a fitter nation. A good idea, though it may not be popular with members of the engineering and other departments, who may have to come on duty at uncanny times. One difficulty that I foresee is the choice of an hour in the morning—I assume that the radio physical jerks will be matutinal—that will suit the greatest number of those whom it is desired to benefit. During the present winter, for instance, the test match relays have caused slugabeds to leave the blankets sooner than is their wont, whilst normal moderately early risers, who seldom miss the 8.15 in the ordinary way, have been hard put to it to find fresh excuses for their tardy arrival at the office. The German stations, I understand, get to work at 5 a.m. or thereabouts, but these activities are decently veiled in the programmes published in this country.

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Recent Inventions

Brief descriptions of the more interesting radio devices and improvements issued as patents will be included in this section.

TELEVISION SYSTEMS

WHEN transmitting say a theatrical performance from the studio, a more advantageous use can be made of the total band of signal frequencies produced if these are concentrated more on the front part of the stage (which is occupied by the actors and shows the movement of the play) than on the background, which remains more or less the same at all times.

Accordingly the actors alone are scanned by one part of the transmitting apparatus, and simultaneously another part of the apparatus scans a scene forming an appropriate background. The two operations are so linked together that the part occupied by the moving actors is cut-out from the background whilst the latter is being scanned. A supplementary background, designed to enhance the moving figures, is provided whilst the actors are being scanned, though the signals produced by this background are prevented from reaching the transmitting aerial. The signals representing the moving actors, and those representing appropriate background, are combined together in correct relative position, before being finally fed to the transmitter.

T. Vrabély. Convention date (Hungary) April 27th, 1934. No. 455785.

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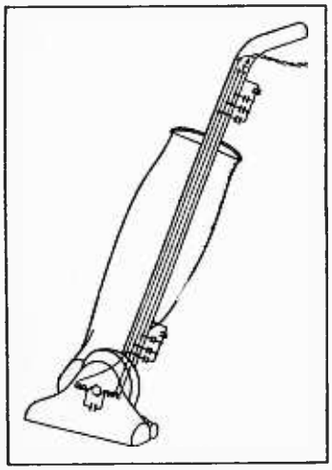
"STATIC" SUPPRESSORS

EACH of the leads from the control switch to the electric motor of a vacuum cleaner is connected through a condenser to a common wire which, in turn, is



Interference suppressors for a vacuum cleaner.

"earthed" through a condenser to the metal framework of the machine. By inserting the suppressor unit at a considerable distance from the brushes of the motor, i.e., at the end near the handle, the inductance of the leads alone is sufficient to render the use of choke-coils unnecessary. Preferably two suppressors are used, as shown, one fitted near the handle and the other near the motor.

C. D. Gwinn and The Telegraph Condenser Co., Ltd. Application date January 20th, 1936. No. 455541.

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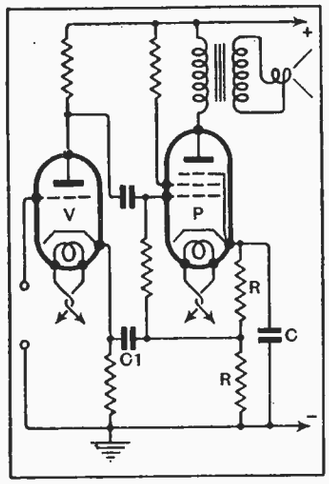
TONE-CONTROL CIRCUITS

THE tone response of a resistance-capacity coupled AF amplifier is varied, and in par-



Method of emphasising bass response in a resistance-capacity coupled AF amplifier.

ticular the lower tones are emphasised, by inserting a resistance R shunted by a condenser C in the cathode circuit of the output stage P, so that it feeds back in-phase voltage to the cathode circuit of the preceding valve V. The amplitude of the feed-back voltage set up across the potentiometer R varies with the tone frequency to a degree depending upon the value of the shunt condenser C, and the resistance R. The lower portion of the latter is pre-set in the course of manufacture. The condenser C1 is of the order of one microfarad, whilst the upper and lower parts of the resistance R are each about 500 ohms.

F. G. Frost and Halcyon Radio, Ltd. Application date March 28th, 1935. No. 456062.

o o o o

TELEVISION RECEIVERS

IT is sometimes desirable to be able to change the size of the scanning spot on the fluorescent screen of a cathode-ray tube. For instance, if high-definition and low definition television programmes were made simultaneously available, some such readjustment of the receiver would be necessary in changing-over from one to the other. At the same time, the spot must, of course, be kept in focus during both conditions of operation.

To secure this result three focusing electrodes are arranged along the path of the stream, the first being a long cylinder, the second a short cylinder, and the third a dish-shaped element. To change the size of the spot, or the "magnification" of the lens system so provided, the potential of the first cylinder is altered; whilst to preserve the proper focus, the potential of the second cylinder is simultaneously changed.

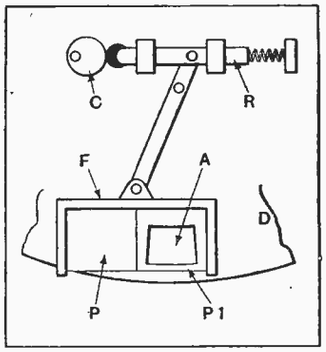
The General Electric Co., Ltd. and L. C. Jesty. Application date, May 16th, 1935. No. 455797.

o o o o

INTERLACED SCANNING

RELATES to means for ensuring the necessary slight displacement of one set of lines from the next, in systems of "interlaced" scanning where the two sets of lines are thrown in succession on to the screen so as to lock together without overlap.

In the arrangement shown, two glass plates P, P1 are mounted at a slight angle to each other in a frame F, which is moved to and fro, by a cam C and spring-pressed rod R, in front of the scanning aperture A in the usual rotating disc D. The to-and-fro movement is so regulated that the glass plate P1 remains in the same position until the first set of picture lines is scanned, and is then replaced by the plate P for the second set. The different angle of tilt of the two plates causes the first set of lines to be displaced from the second by a sufficient amount to ensure the required



System of "interlaced" scanning using rotating disc.

interlacing. Plane glass is preferred to the use of prisms, as it ensures equal displacement without causing chromatic dispersion.

J. C. Wilson and Baird Television, Ltd. Application date, April 30th, 1935. No. 455972.

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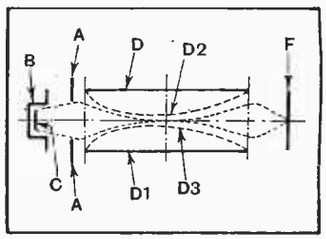
FOCUSING THE ELECTRON STREAM

THE higher the intensity of the electron stream, as it passes under the influence of the deflecting plates in a cathode-ray tube, and the longer the electrons remain in this region, the greater



Arrangement of electrodes in cathode-ray tube to give increased sensitivity.

will be the deflection of the stream, and therefore the more sensitive the response of the tube. But at the same time the greater is the dispersion of the stream, owing to the mutual repulsion of the electrons.

According to the invention, the electrodes of the tube, and particularly the focusing-electrodes, are so arranged as to tolerate a fairly large dispersion, for the sake of the increased sensitivity, though precautions are taken to prevent any undue "spread" of the spot before it is projected on to the fluorescent screen.

As shown in the Figure, C is the cathode, B the concentrating-electrode, and A the perforated anode. The deflecting plates are shown at D, D1, though they may be curved as shown at D2, D3 so as to approach the stream more closely. The innermost dotted lines show the track of the stream, which is brought to a point before it reaches the fluorescent screen F by suitable focusing-electrodes (not shown).

N. V. Philips' Gloeilampenfabrieken. Convention date (Germany) January 31st, 1935. No. 455736.

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DIRECTIONAL AERIALS

IN the known type of aerial "array," as used to radiate a directed beam of wireless energy, it is usual to space the various antennæ apart by a distance of approximately one quarter the working wavelength. The complete aerial system may therefore extend over a considerable space, and for this reason is only practicable for short wavelengths.

The invention describes a method of securing highly directional results on an aerial "array," the elements of which are set closer together than usual. The result is secured by dephasing the supply currents to the various elements by a specified amount, and also by regulating their amplitudes, so as to give either a heart-shaped or figure-of-eight radiation field. Although the radiation for a given current from such a system is less than that obtained from a more widely spaced aerial system, this is offset by the fact that larger aerial currents are developed in each individual antenna.

E. L. C. White and W. S. Percival. Application date April 3rd, 1935. No. 456136.

The British abstracts published here are prepared, with the permission of the Controller of H.M. Stationery Office, from Specifications obtainable at the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1/- each. A selection of patents issued in U.S.A. is also included.

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NEW RECEIVERS AND AMPLIFIERS

A.

A.

DEGALLIER'S, Ltd., the best firm for reliable fully guaranteed ultra short-wave radio, have on view in London without exception the largest selection of all-wave receivers, at very low prices. For instance, a 7-valve superhet., with 3 bands going down to 16 M. in A.C. or A.C./D.C., at £9. An 8-valve superhet., 4 bands going down to 11 metres, with push-pull output 7 watts undistorted, is only 13 guineas. Any known American valve for receivers 1925-1937, glass, glass counterparts, metal, and M.G. at 6/6 each, all firsts. They have range like this right up to a 24-valve Challenger twin-chassis, valves and two Auditorium speakers, 5-bands 5-2,050 metres, 60 watts undistorted at £50 (this is as supplied to the Navy, Army and Air Force canteens). They guarantee that every S.W. receiver will get stations on the low bands including the Americas, etc. Why not call and handle these receivers at your leisure? Demonstrations daily from 3.30 onwards on American transmissions. No obligation to purchase. Or send large S.A.E. for beautifully illustrated catalogues with actual photographs. Also in stock, Ferguson, Emerson, Belmont, Crosley, Garod, etc. DEGALLIER'S, Ltd., No. 18, Connaught St., Marble Arch, W.2. Paddington 2745. [3803

ALERT RADIO Co.

COMMUNICATION Receivers, all-wave chassis, complete receivers of all types, American valves, spares and service; we also have a few reconditioned receivers.—21, East Rd., N.1. Clerkenwell 4871. [3787

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ESTABLISHED 1908.

ALL-WAVE Receivers, suitable for use on ships, as supplied to officers of many shipping lines.

OUR 8 and 10 Metal Valve All-wave Receivers; 15-2,000 metres, acknowledged by the trade as the best for range, tone, and generous performance.

LATEST 6-valve Car Radio, A.V.C., remote control, no suppressors required.

A FULL Range of the World Famous Ferguson and Pilot Models Stocked.

ALL Sets Fully Guaranteed by Ourselves.

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ANY Make of Set Serviced by Our Qualified Radio Engineers at Reasonable Charges.

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ELECTRONIC House, 22, Howland St., Tottenham Court Rd., W.1. Museum 5675. [0511

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An entirely new receiver, combining HARTLEY-TURNER quality with DISTANT RECEPTION. Described as a "medium-range supersonic." Its most important quality is that *for any given interference condition it gives 25% to 50% better band-width than the usual set.* Local reception so near our short-range sets that the difference is usually not perceptible even on quick change-over.

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7 watt output ..	£32	10 0
12 „ „ ..	£35	0 0

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The best speaker we have ever made. Looks like the Duode speaker produced last autumn, but has certain improvements in the design of the cone-to-tube joint that (while giving equally smooth response curve) offers a still closer approach to realism, and allows the speaker to stand up to bigger inputs.

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Our energised standard speaker can be converted to DUODE DE LUXE for ..	£2	10 0
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ALL Sets Fully Guaranteed; H.P. terms available from 3/- per week; our technical department is at your service.

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ARCTURUS Valves for Improved Radio Reception on All Types of Receivers.

WRITE for Lists of These Famous Valves; prices from 4/9 each.

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STATEMENT of Policy.

THE Policy of the Coulphone Radio Mfg. Co., Ltd., of Hutton, Preston, Lancs, is to produce high class radio at a reasonable price; this has been done since 1923; in fact, some over-enthusiastic clients are still using sets built by us in 1924. Example of our productions:—

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CHASSIS, Peerless, latest American 9-valve 3 waves, 8in. speaker. £7/17/6; ditto 11-valve 5 waves 1938 model, 12½in. speaker, enormous power. £14/14.—Kay, 1, Old Church Lane, N.W.9. [0547

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IT LOOKS WORTH £35

IT SOUNDS WORTH £45

IT COSTS ONLY £22.10s.

This is not a riddle and we do not propose to end up with "WHAT IS IT?" but in spite of the faet that the "Wireless World" made a slight error in publishing the price of our new 14 WATT P.A. AMPLIFIER at £35, we have had a number of enquiries for this outstanding model.

THE FACT THAT IT ONLY COSTS £22.10 MAKES AN ATTRACTIVE AMPLIFIER ALL THE MORE ATTRACTIVE.

May we send YOU further particulars?

SOUND SALES LIMITED

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(Contractors to the G.P.O., etc.)

Tel.: Archway 1661/2/3.

You've paid your License
You've got your Set,
AND IF you've used FLUXITE—
You won't need a "VET."

See that **FLUXITE** is always by you—in the house—garage—workshop—wherever speedy soldering is needed. Used for 30 years in Government works and by leading engineers and manufacturers. Of Ironmongers—in tins, 4d., 8d., 1/4 and 2/8.

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ALL MECHANICS *WILL* HAVE

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IT SIMPLIFIES *ALL* SOLDERING

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NEW RECEIVERS AND AMPLIFIERS

ANGLO AMERICAN RADIO Offer the Finest Range of Chassis and Receivers at London's Lowest Prices.

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£9/19/6—9-valve all-wave chassis, 16-2,000 metres, visual tuning, magnificent performance: speaker, 15/6; complete receiver, £11/10/6.

£8/19/6—8-valve all-wave chassis, 16-2,100 metres, visual cathode tuning, 7½in. super airplane multi-indication dial, 4 watts output, A.V.C. tone control, A.C. operation, 110-240v.; matched speaker, 12/6; complete receiver, £10/7/6.

£7/19/6—8-valve all-wave chassis, 16-2,100 metres, new De Luxe 5½in. airplane multi-indication dial A.V.C., tone control, calibrated all bands. 110-240v. A.C./D.C.; matched speaker, 12/6; complete receiver, £9/6/6.

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ORDER with Every Confidenee; any goods unsuitable will be exchanged for any others selected; we have the largest range and lowest prices in the country.

TERMS.—Cash or c.o.d.; carriage on all chassis, 2/-.

IF Near London, call or 'phone for demonstration at time to suit.

ANGLO AMERICAN RADIO (AND MOTORS), Ltd., (Dept. W.5), Albion House, New Oxford St., London. W.C.1. (Telephone: Temple Bar 3231.) [3847

£26 bargain.—Hammarlund Comet Pro, with crystal, complete with all accessories.

£13/13—11-valve all-wave receiver, 4 bands, 12-2,050 metres, selectivity illuminated dial, vernier tuning, incorporating every newest feature, selective, sensitive, amazing quality, 6 watts, undistorted output.

£13/13—8-valve A.C., similar specification to above.

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OUR Guarantee, "satisfaction or money refunded."

RADIOGRAPHIC, Ltd., 66, Osborne St., Glasgow, C.1. [3833

ARMSTRONG COMPANY Manufacture 8 Radio Receivers in Chassis Form, briefly described hereunder.

ARMSTRONG 6-valve All-wave Superheterodyne Radiogram Chassis, for A.C. mains, complete with Rola speaker; £7/10.

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ARMSTRONG 6-valve 4 Wave-band Radiogram Chassis, with large triode output; £8/17/6.

ARMSTRONG 8-valve 4 Wave-band Radiogram Chassis, with radio-frequency stage and push-pull output; £11/11.

ARMSTRONG 7-valve 4 Wave-band Radiogram Chassis, with radio-frequency stage and single triode output; £10/10.

ARMSTRONG 8-valve 2 Wave-band Radiogram Chassis, with 8 watt push-pull output; £8/10.

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ARMSTRONG Chassis Carry 12 Months' Guarantee.

ARMSTRONG Chassis are Sent 7 Days' Trial, carriage, packing, and crate free.

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OBTAINABLE ONLY FROM

GALPINS

ELECTRICAL STORES

75, LEE HIGH RD., LEWISHAM, LONDON, S.E.13.

TERMS: CASH WITH ORDER OR C.O.D.

Telephone: Lee Green 5240.

PERMANENT MAGNET MOVING COIL SPEAKERS by well-known makers, fitted volume tone control, magnificent reproduction, ideal for extension speaker, 8/6 each. Post free. Complete in walnut cabinet, **14/-**. Post free.
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ZENITH VITREOUS RESISTANCES, 3,000 ohms 200 m/A., **2/-**; 2,000 ohms, 100 m/A., **1/-**; 20,000 ohms, 50 m/A., **1/6**; 1,000 ohms, 200 m/A., **1/3**; 120 ohms, ½ amp., **1/-**. Post 3d.
EX-R.A.F. MARCONI R. VALVES, 6 v. Bright Emitter, suitable for small experimental transmitters, Morse practice, etc., **1/-**. Post free.
COSSOR EX-R.A.F. 2-VOLT GENERAL PURPOSE VALVES, as new, 3 for **2/6**. Western Electric 2 mf. Condensers, **9d.** each. T.C.C. 2 mf. Condensers, **1/-**. Microphone Buttons, **9d.** 20-30 H. Mains Chokes, 40-60 and 80 m/A., **1/-, 1/6, 2/6** each. 1,000 ohm Earphones, **1/3** each; **2/-** per pair. 1,000 ohm Bobbins, **6d.** per pair. Small Horseshoe Magnets, **3d.** each. .0003 and .001 Variable Condensers, **1/-** each. Ex-R.A.F. Remote Control Panels, useful for condensers, **1/-** each. Mackie Generators, 12 v. input, 600 v. 75 m/A. output, **30/-**. Ex-R.A.F. Cutouts, 20 v. 3 a., with voltage regulator, **1/9** each. Belling 1 kW. Elements, **2/6**.
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HIGH-GRADE MICROPHONE TRANSFORMERS, various ratios, **3/6**. Post free.
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HAND-DRIVEN GENERATOR, double output, 800 v. at 100 m/A. and 6 v. at 4 amps., can be power driven if required or used as a Rotary Convertor for H.T. output, price **£2/10** -.
FOSTER TRANSFORMER, 220/240 v. input, 50 cycles; output, 2,000 v. at 350 M/amps., **50/-**.
DOUBLE OUTPUT GENERATORS, outputs, 30 volts 15 amps. D.C., and 24 v. 15 amps. A.C., 1 P.H. at 100 cycles can also be used as a rotary convertor D.C. to A.C., **50/-**.
BATTERY AMPLIFIER, fitted 5 valves L.S.5; Weston m/A. meter 0-100 and one 0-10 volts, also 3 Amplion Horn Speakers, type AR, PS1 and two control panels, **£4/10/-**.
FRENCH ASTROLABE, in case, with compass, prism, eyepieces, false horizon, etc., in first-class condition, **£5**.
ROTARY CONVERTORS, one, 220 v. D.C. input, 110 v. A.C. output, 500 watt with smoothing, **£5**; another, 220 v., D.C. input, with two outputs, either 20 v. at 60 amps. D.C. or 825 v. at 1¾ amps. D.C., **£5**; another, 12 v. D.C. input to 1,100 v. 75 m/A. output D.C., **30/-**; another, 12 v., D.C. input to 600 v. 100 m/A., D.C. output, **25/-**; another, 220 v. D.C. input, 25 v. 6 amp. D.C. output, **45/-**.
COFFEE GRINDERS, all complete and for 220 v., D.C. mains: one ⅛ h.p., **35/-**; one ¼ h.p., **45/-**, and one ½ h.p., **55/-**.
NO RO CONVERTOR, input 110 or 220 v. A.C., output 110 or 220 v. D.C., 100 watts, **50/-**.
WORKSHOP FLEX, V.I.R. and Braided, for 5, 10 or 15 amp., in 36-yard coils, **4/6** per coil. Post free.
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MAINS LIGHTING DIMMERS, Slider type, Worm and Wheel drive, 1 kW., **25/-**; 2 kW., **32/6**.
EX-G.P.O. MAGNETIC RELAYS, working current approx. 2 m/A., 7/6 each; post 6d. "Sullivan" Moving Coil Relay, in perfect working order, new condition, **45/-**.

RECEIVERS AND AMPLIFIERS

CLEARANCE, SURPLUS, ETC.

HENRY'S.

SHORT-WAVE Units by Well-known Manufacturer, 13-70 metres, supplied in handsome walnut cabinet, complete with coils, adaptors and instructions, no alterations to your present set, one plug connection, for all A.C. mains or battery sets, listed at £3/3; our price 30/-, carr. pd., in sealed cartons.

HENRY'S, 72, Wellington Ave., London, N.15. Stamford Hill 2907. [3759

CLEARANCE List (Trade Only).—Write Leonard Heys, 36, Henry St., Blackpool. [0527

A BARGAIN List of New Sets from 75/-; Regentone 5-valve all-wave 1937 model, list 12½ guineas, unopened; 8½ guineas.—Write Kay, 1, Old Church Lane, N.W.9. [0535

CHASSIS, superhets, A.C.6, D.C.6, U.5, B.4, T.R.F., D.C.3, C.B.4, B.3, Marconi A.C.4, B.3 cabinet, B.T.H. A.C. Gramotor, Uni Gramotor, 10/-; portable B.5 Regentone, Pathe, cabinets, 5/-; K.B. Amplion, Truvox cabinets, 2/6; rotary converter, 90 W., 230 D.C.-230 A.C., £2/10.—Cook, 20, Lady Somerset Rd., N.W.5. [3849

BATTERY CHARGING PLANT

CARFAX "Junior," 20/30v., 5a., £5/5; guaranteed five years.—British Rectifiers, Vernon Place, Cheltenham. [3573

PUBLIC ADDRESS EQUIPMENT

SPECIAL Offer!!!

8½ Guineas Assembled: Vortexion 20 watt 4-stage P.A. amplifier, in steel case, 8in×10in.×9in. high, with carrying handle, input with controls for microphone and pick-up and tone control, output for 7½ and 15 ohm speakers, weight 25lb.; only 8½ guineas, with valves.

4 Input Model, with mixers; £10.

HEAVY Duty Model, as fitted to cinemas and dance halls; £15.

CALL and Hear the Rumble of an Organ as Never Before on our Wide Frequency Range Models, the best yet.

VORTEXION, Ltd., 182, The Broadway, Wimbledon, S.W.19. See also New Mains Equipment. [3439

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HARMONY HOUSE SOUND SERVICE, Southport.—Beam power amplifiers, 14 watts output; £13/10 (subject); send for lists. [0546

COULPHONE Amplifiers, "sound sound reproducers"; prices £5 to £50; 4 to 70 watts; 12 months' guarantee, including valves. See advert. for "New Receivers." [3845

AMPLIFIED Speech and Music for Fetes, sports meetings, etc., using our public address mobile equipments, also smaller equipments for dinners, dances, conferences etc.—Harmony House Sound Service, Southport. [0548

USED SETS FOR SALE AND WANTED

EKCO

EKCO B37 Consolette, used 6 months, new dry batteries; £3/10, or offer.—Voss, Baker's Cross, Cranbrook. [3841

MURPHY

MURPHY Console, model D24C, D.C. only; £7.—82, Windsor Av., North Cheam, Surrey. [3831

VIDOR

VIDOR Miniature Portable, moving coil speaker, perfect condition; £4/7/6.—D.F.H., St. Clare, Altwood Bailey, Maidenhead. [3825

W.W. MONODIAL

1936 "W.W." Monodial A.C. Super, complete with specified speaker; also "W.W." universal gramophone amplifier; £14 and £5, or offer.—59, Claude Rd., Chorlton-cum-Hardy, Manchester. [3815

NEW MAINS EQUIPMENT

ALL POWER TRANSFORMERS, Ltd.—Transformers and chokes embodying all the best in design; no better value at any price; Radiolympia models; tapped and screened primaries, filaments, centre tapped.

250 0-250v. 60 m.a., 4v. 1-2a., 4v. 2-4a., 12/6, post 7d.; extra filament, 4v. 1a., 12/6.

350 0-350v. 60 m.a., 4v. 2-3a., 4v. 2-4a., 15/-, post 8d.; extra filament, 4v. 1a., 16/-.

350 0-350v. 120 m.a., 4v. 2-3a., 4v. 4-6a., 4v. 1-2a., 19/-, post 1/-; extra filament, 20/-.

500 0-500v. 140 m.a., 4v. 2-4a., 4v. 4-6a., 4v. 2a., 4v. 2a., 29/6, post 1/-.

L.T. Charger, charging rate 1a., 2, 6, or 12-volt, employing metal rectifier L.T.5, 37/6, post 1/-.

WRITE for List; special quotations by return.

ALL POWER TRANSFORMERS, Ltd., 8a, Gladstone Rd., Wimbledon, S.W.19. Tel.: Liberty 3303. [3383

No. 26.

Notes on the Suppression of Electrical Interference with Wireless Reception

We get letters of all kinds from all parts of the world, most of them are very kind. We are particularly proud of one we received from Nottingham last week.

The set was a big one situated only a few feet away from trolley-bus points. Neon signs only three feet away, presumably on the outside wall, an electric storage plant in the next room, and since an †"Eliminoise" aerial was installed, apart from some (apparently) L.F. hum, the receiver could be used to the complete satisfaction of the customer, who thinks the "Eliminoise" is marvellous. So do we! In this case the customer is lucky. Although we would have tried it out we would never have guaranteed that the "Eliminoise" would have done its job so well under such trying conditions.

On several occasions we have been challenged on our statement that in most cases of interference a Set Lead Suppressor such as the Type 300 will do the job even if the interference ceases on removing the aerial from the receiver. The mains lead to a set is where the mains come closest to the aerial lead-in, and the interference jumps across from the mains and enters the receiver via the aerial terminal, hence the illusion, which can be very misleading. Now it will be clear that in such cases if a Set Lead Suppressor is introduced at the plug point, the mains lead to the set is filtered, whereas a similar filter inside the set could not do the job.

A Set Lead Suppressor costs only a guinea, against the "Eliminoise" 35/-, plus cable at 10d. per yard, and possible installation charges.

Most dealers will give you the opportunity to try this suppressor in your own home. If you are not known to them you will be expected to pay in full beforehand, but get an agreement that if it isn't the correct cure in your case that they will refund the money on the return of the undamaged suppressor. If you cannot get this service locally, then write to us and we will in most cases send one C.O.D. If it doesn't do, we will refund your cash less C.O.D. and carriage charges. We can't be fairer than that, can we?

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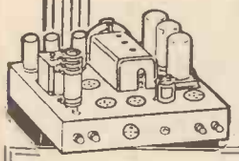

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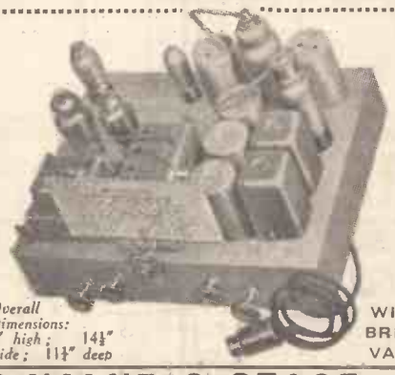

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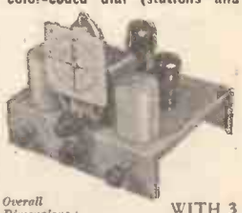

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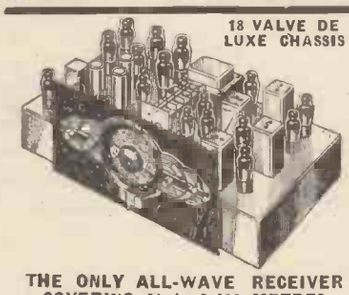

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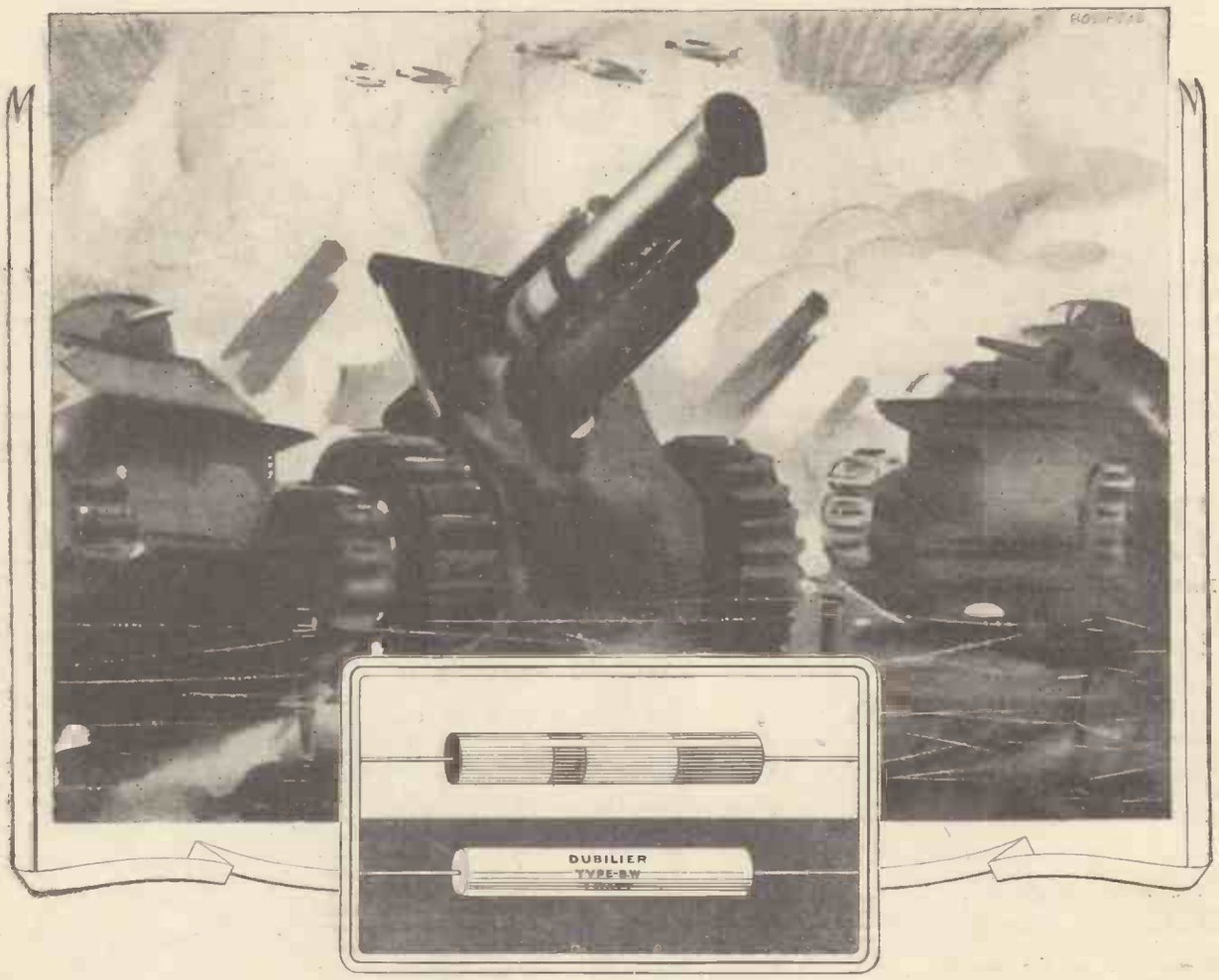

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EDITORIAL COMMENT

Ultra-short Wave Broadcasting

Why This Delay?

THE potentialities of ultra-short wavelengths for high-quality broadcasting have been recognised for a long while, but it remained for television as a service in this country to introduce ultra-short wave broadcasting to the public. The position now is that it is realised that for much of the sound programme of the television transmissions the advantages of the ultra-short wave sound channel are wasted, as this channel can only do justice to quality when the original source of sound is of a high standard. There can be little advantage, for instance, in using the ultra-short wave transmitter as a medium for putting over sound which has previously been recorded on film or disc.

Some time ago the B.B.C. announced that a new ultra-short wave transmitter had been completed and that it was proposed to feed it with the National programme and commence transmissions shortly. This proposal was everywhere received with enthusiasm because it showed that the B.B.C. was alive to the potential importance of the ultra-short waves for broadcasting purposes, and it was felt, too, that a demonstration of this kind would so impress listeners that the advantages of quality reproduction would be widely recognised and other stations would be set up and the service extended in different parts of the country.

Unfortunately, the B.B.C. seems to have constructed this ultra-short wave transmitter without having formulated any policy on the matter. Some days ago we were informed at the B.B.C. that the next move in the ultra-short wave high-fidelity campaign rested with the wireless manufacturers, that the B.B.C. transmitter was ready but that they were waiting for the "trade" to indicate that they were in a position to meet the public demand for ultra-short wave receivers. Surely, if this statement truly represents the official B.B.C. attitude it shows a deplorable lack of appreciation of the position of ultra-short wave reception to-day, and, moreover, would seem to indicate that the B.B.C. is at the beck and call of radio manufacturers on matters of this kind.

When has it in the past ever been the policy of the B.B.C. to wait until sets were available before introducing anything new in transmitter arrangements? We should still to-day be waiting for television to start if any such attitude had been followed. Quite the opposite policy has always been adopted and the B.B.C. conducted television transmissions over a very long period when only a dozen or so receivers were in existence. Even to-day the number, although growing, would not, in itself, justify a television service on this basis.

Amateur Example

The construction of sets for ultra-short wave reception is well within the capacity of the amateur, and it is the amateur who will popularise ultra-short wave reception and pave the way for commercial sales later on.

The B.B.C. should not, we consider, hesitate a day longer in launching an ultra-short wave experimental broadcasting service because of any considerations such as waiting for the readiness of the trade. There is already a large audience for these transmissions, and the commencement of transmissions will do all that is necessary to increase interest so that the supply of receivers will come along automatically to meet the demand.

www.americanradiohistory.com

Ultra-short Waves for Loca

PLANNING FOR THE FUTURE

THOUGH no one yet knows fully what the ultra-short waves—those below 10 metres or 30 megacycles—have in store for us, I believe firmly that in ten years from now the bulk of "local" listening will be done on wavelengths between 5 and 10 metres. If there is a solid foundation for this rather startling prediction (and I shall endeavour to show that there is) it is of the utmost importance that early steps should be taken to control and distribute the available channels in the best way and to get rid of possible sources of interference before they become so deeply dug in that there is little chance of effective action against them.

When broadcasting on the long and the medium waves began there were very few with sufficient vision to appreciate the tremendous part that it was soon to play in national and international life. And there was probably no one who had any conception of the problems that would be raised by the scramble for channels that ensued later, by the vast and rapid increase in the number of broadcasting stations, or by the coming of high-powered transmitters. No one, again, foresaw that interference with reception from commercial and domestic electric appliances, the use of which was to expand at an enormous rate, would one day be one of the major problems of broadcasting.

In a word, we were groping in the dark in those "early" days of fifteen years ago. Hence, like the famous Topsy, our broadcasting systems "just growed." There was no settled plan from the beginning; there could not have been, for we had no idea of the difficulties ahead. From time to time conventions, conferences, committees, and commissions strove as best they could to deal with evils after they had arisen. Too often, though, they were like doctors called in too late to a case; they could administer palliatives, but a complete cure was no longer possible.

Grasping an Opportunity

Since our position during the development of long-wave and medium-wave broadcasting was rather that of the blindfolded man searching in a dark room for a black cat that wasn't there, our failure to do all that might have been done with these wavelengths is excusable; but future generations will find no excuse at all for us if we throw away the wonderful opportunities offered by the ultra-short waves, for we have by now a pretty comprehensive knowledge of the requirements of broadcasting and of the "snags" that are likely to crop up. The chief needs are a reliable service at all times and all seasons, with a close approach to perfection in both transmission and reproduction; the main snag is interference.

Let me try to show now why I believe that the time will come when we shall largely abandon* the long waves and the medium waves for that local listening which probably forms over 95 per cent. of the entertainment which most people derive from broadcasting. One of my chief reasons for holding this view is that, under existing arrangements, really high quality in reproduction is unobtainable. Owing to the huge number of stations that has to be fitted in, the frequency separation on the long waveband is in few instances greater than 8 kilocycles, whilst in some it is 6 kilocycles or less. Droitwich, for example, is 9 kilocycles removed from the Deutschlandsender on the one side

THOSE who have heard the experimental 7-metre transmissions from Broadcasting House will agree that there is nothing far-fetched in the suggestion, made by the author of this article, that local broadcasting may eventually be carried out almost exclusively on wavelengths of that order. It is urged that, while there is yet time, plans should be made to ensure the use of ultra-short waves to best advantage.

but only 8 from Minsk and Reykjavik on the other. Radio-Paris has a 10-kilocycle separation from the 500-kilowatt Moscow No. 1, but one of only 3 kilocycles from Istanbul (5 kW.) and 5.5 from the 20-kilowatt Irkutsk. On the medium waveband the distribution of channels is based on a 9-kilocycle separation. No station has more than this on both sides; some have less.

The result is that commercial receiving sets are often made with an almost complete cut-off at 5,000 cycles or below. There are certain high-fidelity receivers, but one has to live pretty close to a main station to be able to give such a set its head.

* It is unlikely that we shall give them up entirely, for there are considerable areas in England, Wales, Scotland and Northern Ireland, mountainous in character and sparsely populated, which can hardly hope for a short-wave service and will probably continue to be covered for "sound" broadcasting by medium-wave or long-wave transmitters—possibly medium-powered relays.

And there are yet other menaces to reception on the long waves and the medium waves which are likely to become increasingly grave. The first is side-band splutter, which is at its worst when the station causing the trouble is transmitting speech. Research into the working of highly selective receivers done some years ago by the National Physical Laboratory showed that no degree of selectivity could eliminate sideband splutter. The only cure is a far greater frequency separation between stations than can possibly be contrived on these wavelengths.

The second menace is interference on the medium-wave band caused by harmonics of long-wave stations. Some long-wave stations are so prolific in this way that they occupy not just their own channels but several others on the medium waveband.

Interaction of Radio Waves

Lastly there is the "Luxembourg Effect," so called because it was first noticed when Luxembourg, then the most powerful of long-wave stations, first came into action. What it comes to, in a word, is that if a powerful long-wave station and a station in the upper part of the medium-wave band are in a straight line with the receiving aerial, or nearly so, the former appears as a strong background when the latter is tuned in. We are likely to hear a good deal more of the Luxembourg Effect when France's Radio National and Germany's new Deutschlandsender begin to transmit.

What elbow-room do stations require if their transmissions are to be as nearly perfect as they can be made? To what range of frequencies must receivers respond? Some time ago the Bell Telephone Company of America investigated the question very carefully. An amplifier was designed which, with its associated loud speakers, had a good reponse up to rather more than 16,000 cycles. Matters were so arranged that by means of switches the amplifier could be made to cut off at 5,000, 6,000, 7,000 cycles, and so on. In the studio not only music but all kinds of familiar noises were produced before the microphone, and a critical audience in the reception room was asked to say whether or not these sounded real. The audience was not told anything about the point at which a cut-off was being made. Their part was just to say "Now it sounds right," or "That is not quite natural."

It was found that the ear could detect something lacking in the reproduction of many musical instruments if the cut-off was much below 16,000 cycles. More surprising, noises such as those of hand-clapping, footsteps on a board floor, rattling

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Broadcasting

By R. W. HALLOWS, M.A.

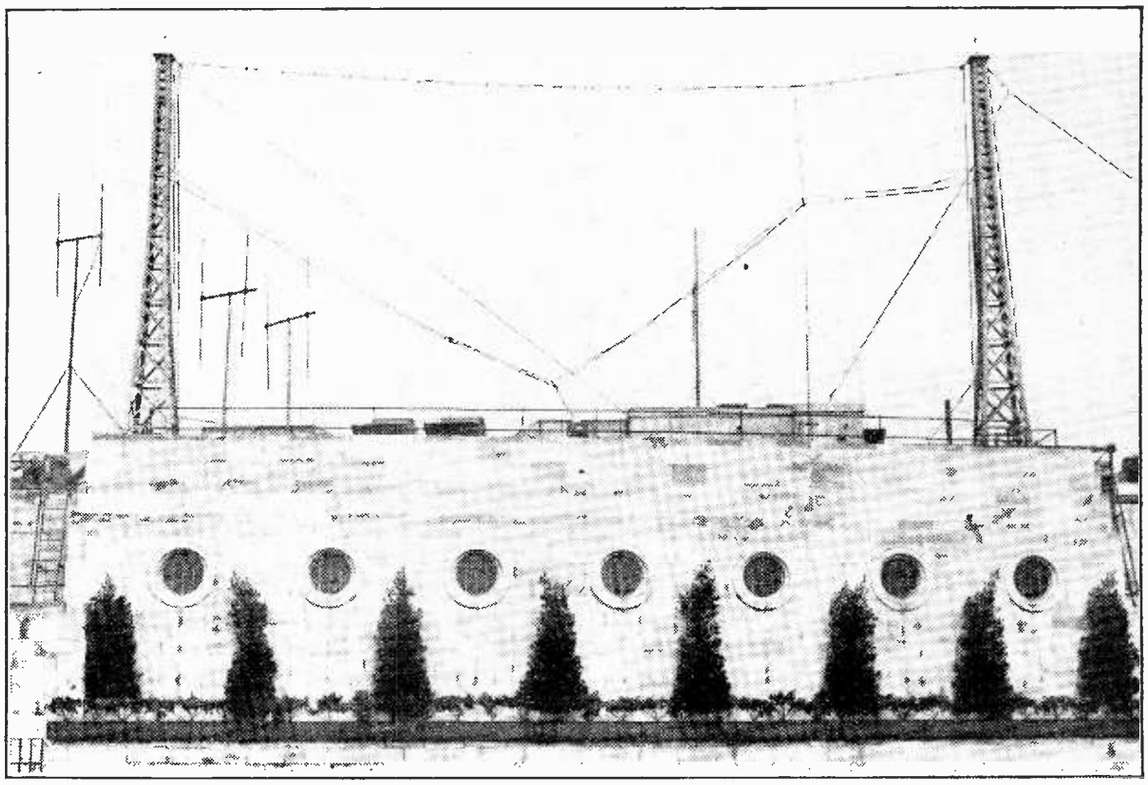
castanets or jingling keys demanded a frequency response up to at least 12,000 cycles.

We may take it, then, that for perfect broadcasting a transmitter needs a total sideband spread of some 32 kilocycles. Any such thing is utterly out of the question on the long or the medium waves.

Nor can the desired separation between stations be obtained on the short waves between 10 and 100 metres, for these are already becoming overcrowded. And there is, in any event, a fatal objection to the use of such waves for local transmission: the size of the skip area surrounding the station.

On the ultra-short waves, on the other hand, it seems as if almost everything that we want is there for the taking so long as we act in time to prevent their gifts from being wasted.

At one time it was believed that the range of any ultra-short-wave transmission was quasi-visual. Nothing, that is to say, would be heard of a transmission at ranges beyond about thirty miles. We know now that this is not so, for the "sound" and vision signals from the Alexandra Palace have been received not only at places in our own country, such as Rugby and Eastbourne, but also in South Africa.



New aerials have recently appeared above Broadcasting House, from where the eagerly awaited ultra-short-wave broadcasts will be radiated.

If the range of ultra-short-wave transmission had proved to be quasi-visual the number of transmitters that could operate simultaneously with sidebands of great width but without mutual interference would have been almost infinite. We shall know more about the way in which these transmissions behave at distances beyond the quasi-optical before much water has passed beneath the bridges; but even in the present state of our knowledge we have a good deal to go upon. Directional broadcasting on these wavelengths is, for instance, readily accomplished. Hence it should be possible, if nations will co-operate, to draw up a scheme of wavelengths and of directional transmitting aerials which would avoid mutual interference.

Suppose, for example, that Great Britain was allotted a band of frequencies in the neighbourhood of 50 megacycles for all her television and sound broadcasting stations† and that transmission on these frequencies were found to "reappear" at a range of 2,000 miles. If transmitters were built to the south of the areas which they served, with aerials directed towards the north, the reappearing signals would do no harm.

Developing the "High-Fidelity" Service

Is an ultra-short-wave broadcasting scheme practicable for this country? I believe that it is, and that it will grow up naturally with the development of television. It could be fostered by making greater use of the sound transmitters of television stations. The Alexandra Palace, for instance, is now connected to Broadcasting House by co-axial cable; why not then relay, say, the Regional programme on the ultra-short waves at all times when television is not toward?

Once the quality of reproduction that is possible on the ultra-short waves has been realised, the demand for high-fidelity transmissions and high-fidelity receiving sets will go up by leaps and bounds. I have noticed, when taking "uninitiated" friends to television demonstrations, that they are often much more impressed by the beauty of the "sound" reproduction than by what they see on the viewing screen.

If the ultra-short waves may have so much in store for us, is it not a positive duty to see that they are not wasted? The problems of channel distribution should be tackled at once, before too many claims have been staked. And above all we should eliminate man-made interference by striking at once at its roots. Probably the worst and commonest kind of interference with ultra-short wave reception is that caused by motor-car ignition systems. It is urgently necessary to discover the best way of rendering them innocuous and to pass legislation making it illegal, within three years, for a car ignition system to radiate interference. Electro-therapeutic appliances and other apparatus radiating ultra-short-wave impulses must also be dealt with immediately.

If action to safeguard the ultra-short waves is taken without delay we can look forward not only to the wide and rapid development of television but also to the coming of "sound" broadcasting without interference and with a quality of reproduction which will at long last almost justify the use of that hitherto sadly mishandled epithet "perfect."

† It seems permissible to assume that no large number of individual television or sound channels would be necessary for the hundred or more ultra-short-wave stations required to serve the country. So far as is known at present, stations situated 100-150 miles apart could use the same carrier frequency without serious risk of mutual interference.

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Electromagnetic Screening

PREVENTING INTERACTION IN AF AMPLIFIERS

By J. E. R. CONSTABLE, M.A., Ph.D., B.Sc.

(Physics Dept., National Physical Laboratory)

THE pick-up of stray fields by audio-frequency transformers, etc., is often responsible for hum, and even for "cross-talk." This article explains the relative effectiveness of various materials for use as a screen to prevent such undesirable effects.

MANY constructors and designers must have experienced difficulties arising from pick-up by an AF input transformer or an intervalve transformer, etc. Usually this undesirable effect appears as hum picked up from a mains transformer or a smoothing choke, possibly some distance away. In these circumstances one first of all moves the affected transformer as far away as possible from the source of hum, and then (for this rarely affords a complete cure) tries twisting it about in mid-air to see if there is any orientation which gives a silent background. It nearly always happens that there is a best direction in which the transformer can point, but, in the author's experience, this is frequently so difficult to obtain that nothing short of mounting the transformer on gimbals would meet the case.

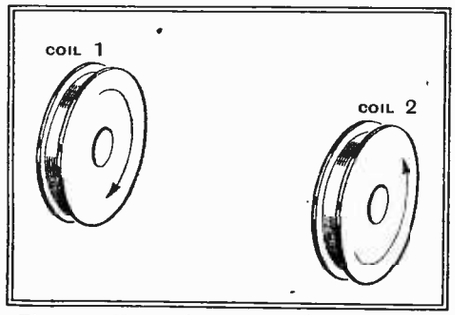

Fig. 1.—How electromagnetic induction takes place between two coils.

It is the purpose of this article to describe how the trouble can be overcome by screening the transformer in a suitable manner. Before proceeding to this it may be as well to examine how the pick-up arises.

Electromagnetic or Electrostatic?

To begin with, it should be realised that this form of pick-up is nearly always electromagnetic and not electrostatic. That is to say, it does not arise from small charges induced on the transformer windings owing to the proximity of neighbouring fluctuating high voltages, but is due to alternating voltages induced in the windings by fluctuating *magnetic* fields, just as the alternating field due to the primary of a transformer induces voltages in its secondary.

Of course, electrostatic pick-up will probably be present also to a small extent, but this can easily be cured by placing a comparatively thin sheet of a good conductor, such as copper, round the transformer; and, as will appear later, treatment for electromagnetic pick-up will settle the electrostatic pick-up at the same time.

Manufacturers usually take some precautions against electromagnetic pick-up by screening the transformer with an iron container. Of course, if the core of the transformer were a closed magnetic circuit the amount of pick-up would be negligible. This condition is never completely fulfilled in practice, however, and if a transformer is placed in an alternating magnetic field a little of the field leaks in. A very small external field can cause quite big effects if the transformer concerned is followed by several stages of amplification. For this reason the measurements described in this article were made.

As stated above, electrostatic screening is merely a matter of placing a good earthed conductor round the transformer. This, of course, is taking advantage of a theory which many of us learned at school, viz., that there is no field inside a charged conductor. Electromagnetic screening, on the other hand, can be obtained in two ways. The first is by doing what was advocated above for electrostatic screening. As the measurements described later will show, this is not very effective for screening against low-frequency pick-up (such as hum), but can be quite useful for screening against higher frequencies such as might be troublesome if, for instance, two powerful amplifiers, each dealing with a different programme, were placed near to each other. The way in which this works can be seen from Fig. 1. Supposing two coils (1) and (2) are placed near to each other as shown. If there is an alternating current in the first, there will be an alternating magnetic field associated with it. This passes through coil 2 and induces an alternating voltage in it. In fact, the combination of the two coils is an air-cored transformer. Now, supposing that, as shown in Fig. 2, a sheet of a good conductor, such as thick copper, is placed between the two coils. There will now also be a current induced in the sheet of metal. This, in its turn, will have an alternating magnetic field which will oppose the field from coil 1. That is to say that the introduction of the sheet of metal has decreased the field passing through coil 2, and hence has reduced the amount of the pick-up. Obviously, the better the conductor used, the more nearly will the original and the "shielding" magnetic fields balance. Hence we should expect a thick metal box to be useful for this purpose.

The other method of obtaining electromagnetic screening is to use a screen of a material with a high permeability, i.e., a material which is very easily magnetised. A simple example would be iron. The way this works is shown in Figs. 3 and 4. In Fig. 3 is represented a coil placed in a magnetic field. If this field is alternating (we may suppose that it arises from a mains transformer) there will be an alternating voltage induced in the coil. Now suppose we surround the coil by a magnetic material as in Fig. 4; the magnetic lines of force no longer proceed along the straight paths shown in Fig. 3, but are, so to speak, drawn into the magnetic material. The coil is thus in a comparatively field-free space, and hence is screened from pick-up. The more magnetic the screen is the more will the space inside it be swept clean of magnetic field.

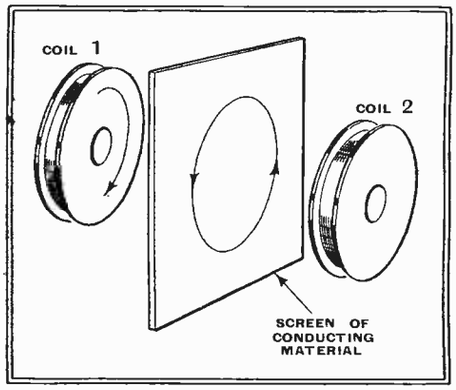

Fig. 2.—A sheet of copper or similar material acts as a shield by virtue of its high conductivity.

With the object of testing the relative efficiency of these two methods of screening, the author, in conjunction with Dr. G. H. Aston, has recently made some measurements at the National Physical Laboratory upon a number of possible screening materials. The measurements

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Electromagnetic Screening—

were made as follows: Two inter-valve transformers were used about one foot apart. One was used as the input transformer to a three-stage amplifier, and about 5 volt-amps of alternating current was passed through the windings of the other. The result was, of course, pick-up with a vengeance. The process was then to place screens of various materials round each of the transformers in turn and to measure the effect of the screens by varying the gain of the amplifier until the pick-up, as measured on its output terminals, was the same as before the screen was introduced. The amount by which the gain had been changed then gave a figure for the screening efficiency of the material. The screen was used round each transformer, as it was possible (indeed, with one material it actually was so) that the screen might be more effective round the pick-up transformer than round the exciting transformer or vice versa.

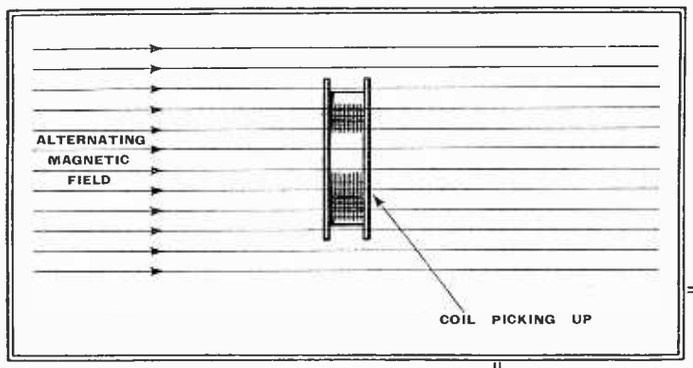


Fig. 3.—A coil in a magnetic field may be isolated . . . .

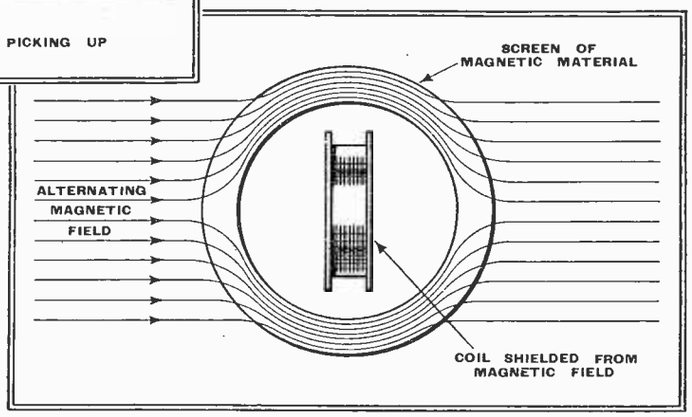
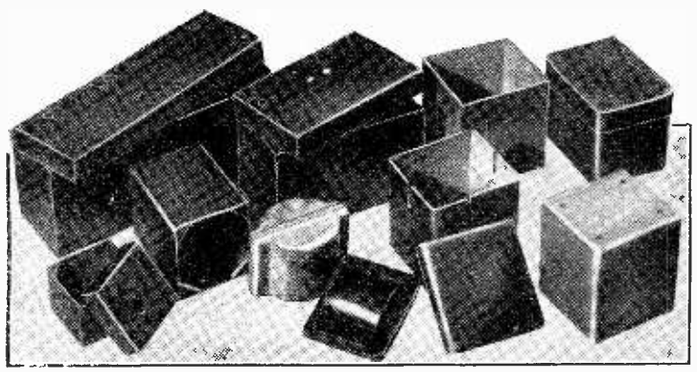


Fig. 4.— . . . . by surrounding it with a screen of magnetic material.



High - permeability nickel - iron alloy shields for transformers, chokes, etc.

(Courtesy The Telegraph Construction and Maintenance Company)

The screening materials consisted largely of the sort of thing which might be found in a laboratory — copper, aluminium, transformer iron, iron, and some special boxes of high-permeability alloy (Mumetal), which were supplied by the Telegraph Construction and Maintenance Company. The shielding (in decibels) obtained at various frequencies is given in the table reproduced. It will be recalled that the shielding in decibels equals twenty times the common logarithm of the ratio $\frac{\textit{pick-up voltage without shield.}}{\textit{pick-up voltage with shield.}}$ Thus a shielding of 20 db. means the pick-up voltage is reduced tenfold, and 40 db. means hundredfold, and so on.

It will be seen that at high audio frequencies (6,400 c/s) all the materials tested had small shielding properties, with the exception of copper, brass, and high-permeability alloy. This is not serious, however, because the pick-up is very much less at these frequencies. It will be seen that it is readily possible to obtain large shielding effects at the other frequencies, however. For screening against mains hum (usually 50 cycles) $\frac{1}{16}$in. high-permeability alloy is seen to be without a rival. Brass, cast-iron, and aluminium are useful for this frequency provided they are sufficiently thick. Probably thick copper would be equally useful; this was not measured, however. Thin iron and steel are of very little value at any frequencies. Shielding against frequencies other than mains hum is probably most often needed when "cross-talk" is to be avoided, as, for instance, when two neighbouring amplifiers are relaying different programmes. It will be seen that for frequencies between 400 and 3,200 cycles a number of materials have valuable properties. Even quite thin copper has shielding effects comparable with that of the high-permeability alloys at the higher frequencies. In the light of the explanations given earlier it will be understood that the copper acts by virtue of its high conductivity, while the high-permeability alloy acts, as its name implies, mainly by virtue of its permeability. There is one other fact which emerges from these experiments, viz., that, while the majority of materials act equally well whether they shield the pick-up transformer or the transformer responsible for the mischief, high-permeability alloy is best used round the pick-up transformer. This behaviour is understandable when it is recalled that the permeability of the material rises to a maximum and then decreases as the magnetic field increases, and that the magnetic field in the vicinity of the pick-up transformer will naturally be less than that near the exciting transformer. Designers of amplifiers should be grateful for this result, for shielding a small intervalve transformer is a far simpler task than shielding the mains transformer.

Constructors who are troubled with hum suspected to be due to pick-up should first ascertain whether it is electrostatic in origin. If it is, a screen of tinned iron round the transformer and copper braiding round the leads should cure it. If, when these measures are taken, some hum remains which can be decreased by moving the transformer, electromagnetic pick-up is very probably the cause. The shielding box required in this case can be of thick aluminium or iron if the pick-up is not large. If considerable shielding is thought necessary, then high-permeability alloy should be used. It should be mentioned, however, that screening boxes of this material require special heat treatment after construction, and are probably best purchased ready-made from firms which specialise in this work.

TABLE.—Shielding effect (on a decibel basis) of various materials when used to screen one transformer from another.

Frequency (cycles per sec.)	Transformer iron, thickness $\frac{1}{64}$in.	Steel, thickness $\frac{1}{16}$in.	Copper, thickness $\frac{1}{32}$in.	Lead, thickness $\frac{1}{8}$in.	Brass, thickness $\frac{1}{4}$in.	Aluminium, thickness $\frac{1}{4}$in.	Cast iron, thickness $\frac{1}{4}$in.	High-permeability alloy, thickness $\frac{1}{16}$in.	
								Enclosing pick-up transformer.	Enclosing exciting transformer.
50	4	6	4	4	10	12	12	36	30
100	5	6	5	7	12	17	13	37	28
200	4	6	8	10	16	20	16	36	29
400	4	7	12	16	22	26	24	35	29
800	4	7	18	24	30	32	41	34	30
1,600	6	8	24	32	40	31	33	32	29
3,200	6	6	26	22	30	20	20	26	22
6,400	8	6	13	8	15	8	8	20	8

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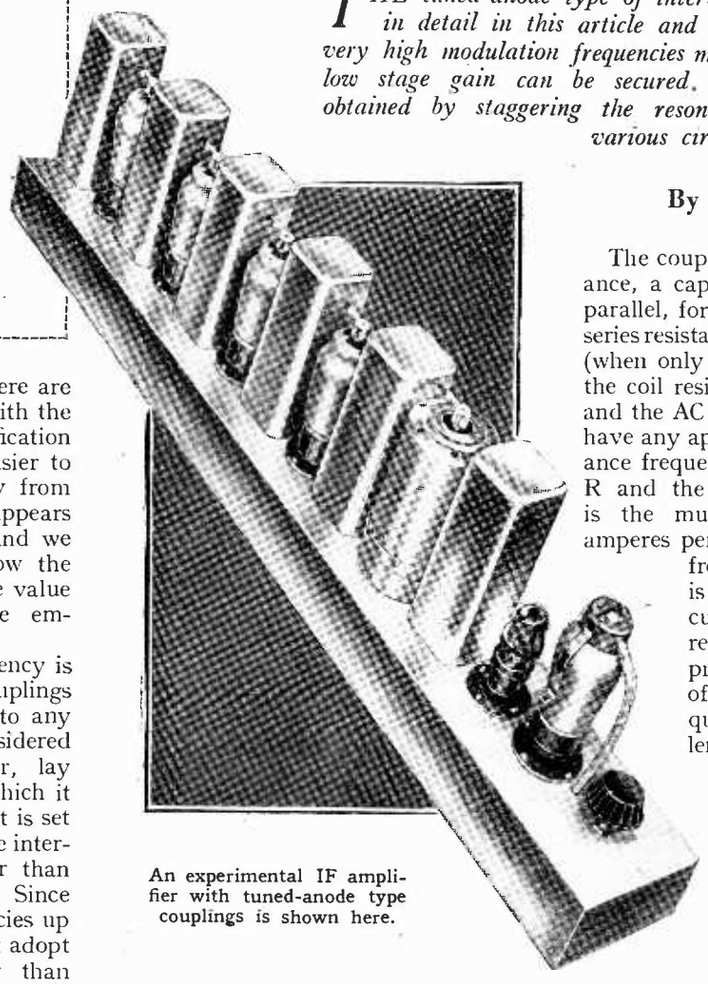
The Television Receiver

III.— SUPER-HETERODYNE IF AMPLIFIERS

THE tuned-anode type of intervalve coupling is treated in detail in this article and it is shown that when very high modulation frequencies must be retained only a low stage gain can be secured. The best results are obtained by staggering the resonance frequencies of the various circuits.



An experimental IF amplifier with tuned-anode type couplings is shown here.

By W. T. COCKING

IT was shown in Part II that there are certain difficulties connected with the use of vision-frequency amplification and that it is consequently easier to feed the cathode-ray tube directly from the detector. The superheterodyne appears to be the most suitable receiver and we have consequently to consider now the circuits of the IF amplifier and the value of intermediate frequency to be employed.

The choice of intermediate frequency is bound up with the type of couplings adopted, so that we cannot come to any definite decision until we have considered the couplings. We can, however, lay down certain broad limits within which it must lie. The lower frequency limit is set by the modulation frequency, for the intermediate frequency must be higher than the highest modulation frequency. Since we have to cater for vision frequencies up to perhaps 2.0 Mc/s, we should not adopt an intermediate frequency lower than 2.5 Mc/s. The upper limit is not set by any theoretical considerations and can be as high as we like. If we make it too high, however, we shall lose much of the advantage of the superheterodyne and might just as well use a straight set. Practically, it is better to keep the frequency below 15.0 Mc/s than higher, and we can adopt this arbitrary figure for our upper limit.

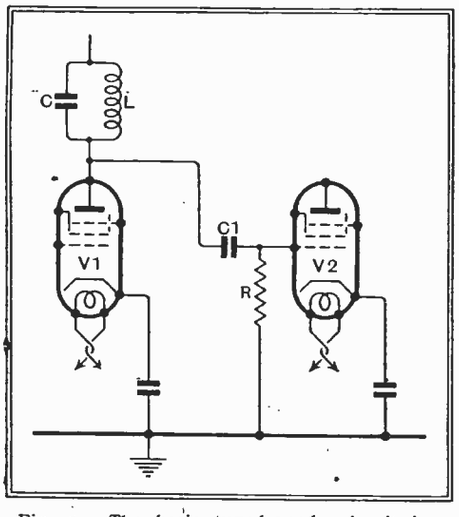


Fig. 5. The basic tuned-anode circuit is shown in this diagram. For the highest efficiency the tuning condenser C consists merely of the valve and stray capacities.

We have now to consider the type of intervalve couplings which we can adopt, and when we have learnt something about their characteristics we can return to a consideration of the amplifier as a whole. The first coupling that one thinks of is the familiar tuned anode shown in Fig. 5. It will appear later that to avoid sideband cutting the tuned circuit must be very heavily damped, so heavily, in fact, that it is not usually possible to wind a coil of high enough resistance even with the aid of resistance wire! In these circumstances it is convenient to damp the circuit by means of a parallel resistance which can well be the grid leak R.

In what follows, it is assumed that C1 is at least 100 times the grid-cathode capacity of V2 and that its reactance at the lowest frequency in the band passed is very small compared with the value of R. The capacity C is then taken to include not only the capacity of any trimmer so placed, but the sum of the input and output capacities of V2 and V1 respectively, the self-capacity of the coil L, and the stray wiring capacities.

The coupling then consists of an inductance, a capacity, and a resistance, all in parallel, for with very heavy damping the series resistance of the coil can be neglected (when only moderate damping is adopted the coil resistance may have some effect) and the AC resistance of V1 is too high to have any appreciable effect. At the resonance frequency the impedance is equal to R and the amplification $A = gR$ where g is the mutual conductance of V1 in amperes per volt. At frequencies different from resonance the amplification is lower, but quite easy to calculate. More often, however, we require to solve the converse problem and calculate the values of components to give the required performance. This problem can be solved easily with the aid af the curves of Fig. 6; these curves enable the value of the product CR (R in ohms, C in $\mu\mu$F.) to be read off for any given attenuation at the limits of the band and for a number of different band-widths.

Calling the resonance frequency f_r, we require to pass a band of frequencies equal to $2n$, where n is the highest modulation frequency required. The two frequencies corresponding to the limits of the band are f_2 and f_1, so that $f_2 - f_1 = 2n$; the intermediate frequency f_i is such that $f_2 - f_i = f_i - f_1 = n$ and the resonance frequency $f_r = \sqrt{f_1 f_2}$; it is nearly, but not quite, equal to f_i. The relationship between these frequencies is probably most clearly seen from Fig. 7. When the intermediate frequency is considerably larger than the modulation frequency the difference between f_r and f_i is negligible, but this is not the case when the intermediate frequency is low and the modulation frequency high.

Circuit Values

The design procedure is easy and is as follows: Decide on the intermediate frequency f_i, say 8.0 Mc/s, and the highest modulation frequency n, say 1.5 Mc/s. Then

$f_2 = f_i + n = 9.5$ Mc/s.
$f_1 = f_i - n = 6.5$ Mc/s.
$f_r = \sqrt{f_1 f_2} = 7.89$ Mc/s.
$2n = 3.0$ Mc/s.

Decide on the attenuation permissible at

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The Television Receiver—

f_1 and f_2, say 1 db., and read off the value of CR from the curves of Fig. 6. For the case under consideration we have attenuation 1 db. and $2n = 3.0$ Mc/s, so that CR = 27,600. The stage gain is proportional to R, so that it will pay to make C as small as possible. Even if we decide to employ no trimming capacity and tune by the stray capacities alone it is unlikely that we shall be able to make C lower than about 25-30 $\mu\mu$F. Assuming C = 27.6 $\mu\mu$F., R = 1,000 ohms. The highest mutual conductance we can at present obtain from an RF pentode is about 6.0 mA/v.; this is obtainable with a Mullard TSP4, but the total current consumption is about 20 mA. Even with this valve the stage gain is only 6 times, so that to obtain a gain of over 40,000 times six stages would be needed. Actually, more would be required, for as the frequency-changer has a conversion conductance of some 0.6 mA/v., it will attenuate. Thus we should probably have to use about seven stages, and this will mean eight couplings; therefore, the overall loss at 1.5 Mc/s off tune will amount to as much as 8 db.

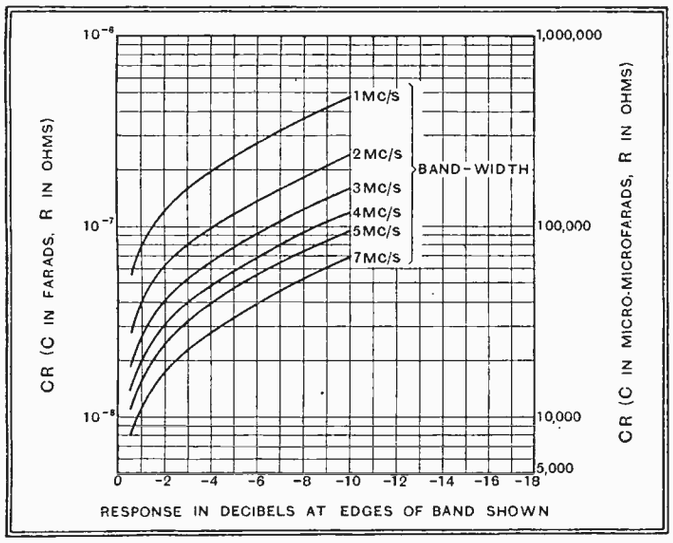


Fig. 6. These curves enable the CR product to be read off for a wide range of band-widths.

It is thus clear that this type of coupling is by no means ideal, but it should not be too hastily condemned, for in somewhat modified form it can be very useful. It must be mentioned to complete the design data that the value of inductance L (in henrys) $= 1/\omega_r^2 C$ where $\omega_r = 6.28 f_r$ and C is in farads.

Several important points regarding this coupling emerge:—

1. For a given band-width and attenuation, the stage gain is independent of the resonance frequency f_r.
2. The stage gain is inversely proportional to the capacity C.
3. The stage gain is inversely proportional to the band-width $2n$.
4. The stage gain increases as the attenuation at the edges of the pass-band increases.
5. The selectivity outside the pass-band is poor.

The next logical circuit to employ is a pair of coupled tuned circuits forming a band-pass filter. In spite of the fact that the efficiency of such a coupling is only 50 per cent. of that of a single circuit, it is actually possible to secure higher amplification. The 50 per cent. efficiency rating presupposes that the tuned circuits are identical in the two cases. Because of the approach to a band-pass characteristic obtainable from a coupled pair the circuits do not need damping so heavily. Moreover, the capacity of each circuit can be lower because there is only one valve connected to each, so that a higher value of inductance, and hence resistance, can be used. The net result is that for a given band-width a pair of coupled circuits gives slightly higher gain than a single circuit and is, of course, much more selective outside the pass-band.

There are, nevertheless, certain difficulties connected with their use. The coupling required is very tight and must be correctly adjusted; if it is too loose, the amplification suffers and the resonance curve becomes too sharp; if it is too tight the resonance curve becomes double-peaked and usually asymmetrical. For the best results optimum coupling must be used and each circuit tuned exactly. As soon as one puts on a trimmer, however, the total capacity is increased and the gain falls. In practice, in spite of a theoretical stage gain of 9, the writer has usually found it difficult to exceed 6 per stage because of these tuning and coupling difficulties. The resonance curve, however, has a much better shape.

Design data for couplings of this type are not given here, for they are quite complex, and moreover, building the couplings to fit the required values is by no means an easy matter. When one relies upon stray capacities for tuning one must be prepared to tolerate variations between the resonant frequencies of the different circuits which naturally adversely affect the stage gain, yet to no greater degree than would be the case if trimmers were fitted.

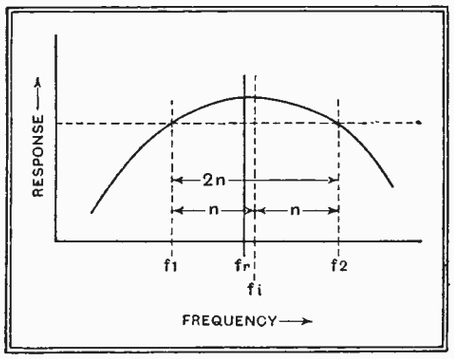


Fig. 7. This diagram illustrates the various frequencies referred to in the article.

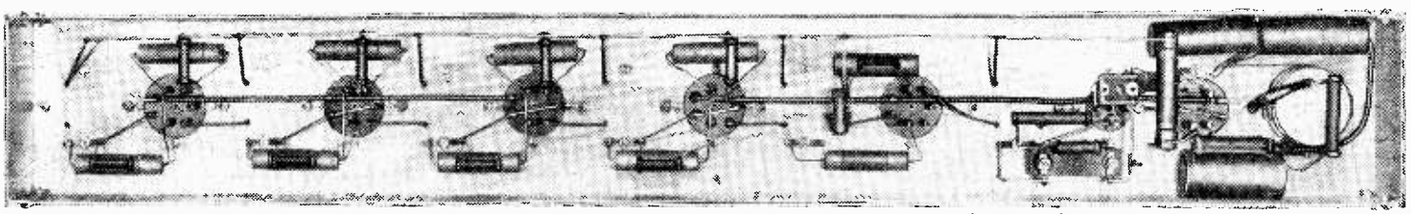
The writer has built a large number of IF amplifiers of widely differing types, and he found that the ones embodying coupled pairs of circuits had variable characteristics in that the shape of the resonance curve depended on the setting of the sensitivity control. With up to about three stages in circuit good performance was obtainable and the departures from the theoretical results were of a small order and due to unavoidable variations in the values of components. With more stages, however, and five are really necessary, the characteristics began to change markedly with the setting of the sensitivity control, the correct resonance curve being secured only at low gain.

This effect was due to regeneration which was present in some degree in spite of thorough decoupling and screening. Regeneration is always bad in television gear since it sharpens the resonance curve, but it is particularly bad when coupled circuits are used because it nearly always renders the curve markedly asymmetrical.

Staggered Tuning

Although band-pass filters can be made to work well and may eventually be widely adopted, in the writer's opinion they are not necessarily the best arrangement, particularly for experimental use. Other methods are available which enable higher stage gain to be secured with less critical adjustment of the couplings.

Now it will have been observed that the poor performance of the tuned anode coupling is due to the heavy damping which must be imposed to preserve the



An underview of an experimental IF amplifier.

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sideband frequencies. Further, it is clear that a pair of coupled circuits has more desirable characteristics because less damping is required and that this is so because such circuits tend to produce a double-humped resonance curve through their mutual interaction. The improved selectivity results partly through the lower damping and partly because there are two circuits in the coupling instead of one.

It is well known that a band-pass type of resonance curve can be obtained, even when only single-tuned circuits are used in an amplifier, by the simple process of mistuning the circuits in certain stages in opposite directions. It should then be possible to use less damping in the different stages and obtain better amplification.

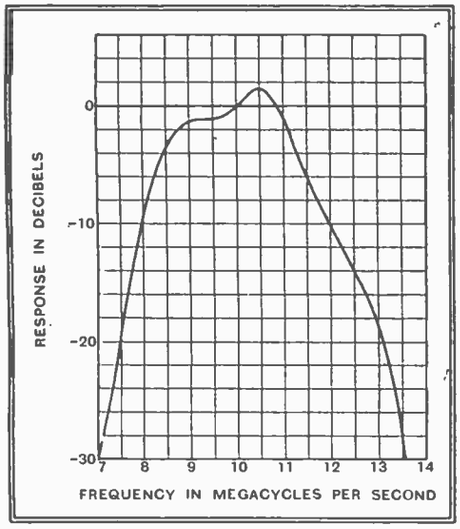

Fig. 8. The measured resonance curve of a five-stage amplifier having a gain of about 15,000 times is shown here.

In practice it is possible to obtain a considerable improvement in performance in this way. The theoretical design can be carried out with the aid of the data already given with the addition of a certain amount of trial and error in regard to the amount of mistuning to be adopted. The selectivity S of a single circuit is given by $S = \sqrt{[1+4\pi^2C^2R^2(f_r^2-f^2)/f^2]}$.

The resonance curve of Fig. 8 shows what can be done in this direction. The amplifier consisted of four TSP4 valves feeding an N43 output stage and a D42 detector and the curve represents the overall performance from the grid of the first IF valve. In practice, of course, an additional coupling would be used between the first valve and the frequency-changer and this would tend to iron out the small hump and improve the selectivity somewhat. This amplifier has a pair of coupled circuits before the detector and single circuits in all other stages. Only two circuits are mistuned, one to 8.5 Mc/s and the other to 11.5 Mc/s, the mid-band frequency being some 10.0 Mc/s. The gain is of the order of 15,000 times, the input to the first IF valve for 30 volts p-p detector output being 2.08 mV. (RMS).

Since the gain is about 15,000 times and there are five stages the average stage gain is $\sqrt[5]{15{,}000} = 6.85$. In view of the high values of stray capacities unfortunately present in certain circuits this is higher than can be obtained with all circuits tuned to resonance.

Before concluding this section it should be pointed out that although the circuits described have been treated primarily from the point of view of their use in the IF amplifier of a superheterodyne they are equally suitable for a straight set. The differences in design are only those brought about by the different operating frequency.

DISTANT RECEPTION NOTES

THE very day that my enquiry whether anyone had managed to log Jerusalem appeared in print I met a North Country enthusiast who had not only heard the station frequently, but was distinctly annoyed with it for providing at times an unwanted background to the North Regional programmes. On returning to my own set I tuned to 449.1 metres, and found that with the volume control turned a good deal farther towards the maximum than I should normally have it for the reception of North Regional a station that must be Jerusalem was audible in the evenings during pauses or intervals in the B.B.C. programmes.

With me it is certainly not sufficiently strongly received to make an annoying or even a noticeable background in the ordinary way. I had noticed this signal before, I see, on referring to my diary, but had taken it for a harmonic of Warsaw working slightly off its wavelength or of one of the eastern Russian stations which do not appear in the usual published lists. Several kind readers have sent reports of reception of Jerusalem.

Hilversum No. 1 is not at all happy with the 150-kilowatt Radio Romania (*née* Brasov) as a wavelength partner. The amount of interference varies curiously—this evening, as I write, there is none; last night it was poisonous. It is reported that the Dutch authorities are going to have something to say about it at the forthcoming Berlin Conference. But, really, they seem to have hardly a leg to stand on. Under the Lucerne Plan Holland was allocated a long-wave channel on 1,345 metres, but refused it on the ground that Hilversum (or Huizen, as it then was) had established a claim by long use to a wavelength above 1,800 metres.

The 1,875-metre wavelength was given at Lucerne to Brasov, but as this was a mere 1-kilowatt station at the time, and could not do much harm, the Dutch authorities proceeded to grab the channel with Huizen and the still more powerful Kootwyk. Meantime, as the 1,345-metre channel was apparently going a-begging, it was thrown into the general melting-pot at a subsequent conference on the long waves. There is now no such thing as a 1,345-metre channel, and one does not see how even an entire recasting of the long-wave table could manage to give Holland an individual wavelength.

Sad though one is to think that such a fine station as Hilversum No. 1 can't now be fitted in as a solo performer on the much-overcrowded long waveband, one can't help recalling the old jingle that

"The fault of the Dutch
Is giving too little
And asking too much."

Very shortly now the French Government stations should provide British listeners with some fine varied fare. Under the Ferié Plan there are fourteen of them, and they are to radiate no fewer than five alternative programmes daily.

At wavelength-allocation conferences France and other European nations have rather stressed the principle that a country which has been allotted numerous individual channels hardly deserves to retain them, in face of the enormous demand, if it uses them for the simultaneous broadcasting of but one or two programmes. The B.B.C. might do well to take a leaf out of France's book and to recall that there is very considerable opposition to our retention of a good many channels for the radiation of but two main programmes.

Television Programmes

Transmission times are from 3-4 and 9-10 daily.

Vision	Sound
45 Mc/s.	41.5 Mc/s.

FRIDAY, FEBRUARY 26th.

3, Gilbert Webster shows how to play drums and other percussion instruments. **3.15,** British Movietonews. **3.25,** Friends from the Zoo, introduced by David Seth-Smith. **3.40,** Film. **3.50,** Starlight: Peter Dawson.

9, The Composer at the Piano: Henry Hall. **9.15,** Gaumont-British News. **9.25,** Repetition of 3.25 programme. **9.40,** Film. **9.50,** Cabaret.

SATURDAY, FEBRUARY 27th.

3, Grave and Gay: two plays. **3.15,** In Your Garden: C. H. Middleton. **3.30,** Gaumont-British News. **3.40,** Lilli Palmer in "Ivorine," a little show.

9, Repetition of 3 and 3.15 programmes. **9.30,** British Movietonews. **9.40,** Nina Mae McKinney in "Ebony," a little show.

MONDAY, MARCH 1st.

3, Golf. **3.20,** Gaumont-British News. **3.30,** International Cabaret.

9, Clara Novello-Davies' Royal Welsh Ladies Choir. **9.5,** Marionettes. **9.20,** British Movietonews. **9.30,** International Cabaret.

TUESDAY, MARCH 2nd.

3, The Orchestra and its Instruments—V: Philip Thornton on keyboard and percussion instruments. **3.20,** British Movietonews. **3.30,** "After Supper": a revue.

9, Repetition of 3 programme. **9.20,** Gaumont-British News. **9.30,** Repetition of 3.30 programme.

WEDNESDAY, MARCH 3rd.

3, Starlight: Warner and Darnell, duettists **3.10,** Illustrated talk on the British Pavilion at the International Exhibition in Paris, 1937. **3.20,** Gaumont-British News. **3.30,** Thirty-third Picture Page.

9, Cabaret. **9.20,** British Movietonews. **9.30,** Thirty-fourth Picture Page.

THURSDAY, MARCH 4th.

3, New Styles in Hats: Fashion Parade. **3.15.** British Movietonews. **3.25,** Jack Payne's band,

9, Repetition of 3 programme. **9.15,** Gaumont-British News. **9.25,** Cook's Night Out—1V: Marcel Boulestin's Cooking Demonstration. **9.35,** Cabaret

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Current Topics

EVENTS OF THE WEEK IN BRIEF REVIEW

Wireless Arrest

A TWENTY-ONE-YEAR-OLD wireless fan, on whom the Norwegian police descended recently for operating a transmitter without a licence, has now been charged with espionage. It is alleged that he was in the pay of a certain foreign Power. He is said to have been transmitting messages in code to aircraft of unknown nationality which were recently reported to be passing over Northern Norway during the night.

Television Exhibition in June

THE first public exhibition devoted solely to the development of television will be opened at the Science Museum, South Kensington, during the early part of June. All the principal British radio manufacturers and also the B.B.C. are co-operating in order to make it a success. The exhibition will cover the period 1873 to 1937. Although it may seem absurd to think of television originating sixty-four years ago, yet it was in 1873 that the first photo-electric cell was discovered, and, of course, the photo-cell is the very heart of television. The first photo-cell was a piece of the metal, selenium, which a telegraphist named May found to vary in its electrical resistance according to the degree of light falling upon it.

Questions in the House

THE P.M.G. at question time in the House of Commons recently emphasised the fact that the B.B.C. is not responsible for choosing or rejecting any particular system of television. The P.M.G. made it clear that he himself, acting on the advice of the Television Advisory Committee, was charged with this responsibility. The P.M.G. rejected the proposal that reports of Parliamentary proceedings which the B.B.C. intend to broadcast should first be submitted to Party Whips for their approval.

French Radio Reforms

IT is stated in Paris that the privately owned broadcasting stations in France are to form themselves into a union in order to establish a minimum tariff for radio publicity. The proposed union will, it is hoped, do much to end many of the abuses associated with this form of publicity.

Music and Radio Exhibition

NEXT summer it is proposed that a combined wireless and music show shall be opened in Copenhagen. Hitherto there has been bitter warfare between the broadcasting authorities and the ordinary concert halls, who saw in radio a menace to their interests. Leading Danish musicians have for the most part been ranged on the side of the concert halls. It is said, however, that the musical interests have at last realised that broadcasting has come to stay and have very wisely made peace with the enemy. To a certain extent this proposed exhibition is the result of the ending of the feud.

Phototelegrams

IT is now possible to send drawings, sketches, and printed matter to the Argentine Republic by the new phototelegraphic service which has recently been inaugurated by Cables and Wireless, Ltd.

Interaction of Radio Waves

PROF. V. A. BAILEY advises us that in connection with his letter on the above subject, which appeared in the issue of *The Wireless World* of February 12th, he hopes readers will be on the look-out for special

THE DUO-TRAC SOUND PROJECTOR, which is being shown and demonstrated at the British Industries Fair at Olympia, has the sound recorded on a film which gives 30 minutes' playing time with a spool of standard size. The apparatus shown above is a table model and embodies an all-wave radio chassis.

Short-wave Therapy

FOLLOWING experiments made in Paris, it is now reported that Dr. Reiter of Vienna, working independently, has succeeded in curing malignant tumours in animals by subjecting them to the influence of wireless waves. The wavelength used is in the neighbourhood of 3 metres. Lest undue hope should be aroused, it is explained that this does not necessarily mean that similar results would be obtained in the case of human beings.

He is in communication with the Chief Engineer of the Irish Free State Posts and Telegraphs to see if it is possible to use Dublin (222.6 metres) as an interaction-causing station, and tests which he is trying to arrange to carry out on Monday night, March 1st, and Friday night, March 5th.

Athlone (531 metres) to provide a steady carrier wave.

These test radiations would take place during some half-hour between 11.15 p.m. and 12.35 a.m. At the moment of going to press the arrangements are not definitely made.

Prof. Bailey also asks that readers should listen to Athlone to-morrow (Saturday) evening, about 10.45 p.m.

Hebrides Wireless Link?

IT is possible that experiments will be made with a view to linking the Hebrides to the mainland by wireless telephony. Much naturally depends on the success of the recently reported experiments of the G.P.O. Engineering Department in the Orkneys. It has been suggested that a suitable site for the mainland station is at Ganavan Sands, near Oban.

First SW Programme Commemorated

A MONUMENT has recently been erected at Eindhoven, Holland, by the well-known Philips Company, to perpetuate the memory of the "First transmission of European broadcasting on short waves on March 11th, 1927." The monument consists of a female form poised on a sphere.

Television in the Cinema

EVERY Friday night at 9 p.m. a demonstration of Baird's Super-screen Television is included in the regular programme at the Dominion Theatre, Tottenham Court Road, London, W.C.2. Various stage and radio personalities appear on the screen, and members of the audience are enabled to ask questions and receive an answer from the person being televised.

Australian SW Transmissions

DURING March Sydney (VK2ME), working on a frequency of 9,590 kc/s (31.28 metres), will be heard from 0600 to 0800, 1000 to 1400, and 1430 to 1630 (GMT) every Sunday. Melbourne (VK3ME) will be heard daily except on Sunday from 0900 to 1200, using a frequency of 9,510 kc/s (31.5 metres).

German Programmes for Belgium

IT is well known that the two official languages of Belgium are French and Flemish, and that programmes are radiated in both these languages. A strong demand has now been made that programmes in certain parts of Belgium be radiated also in German. This is for the benefit of those Belgians living in the Eastern Provinces, in some of which German is largely spoken.

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The Interaction of Radio Waves

THEORY OF THE MODULATION PROCESS IN THE IONOSPHERE

By V. A. BAILEY, M.A., D.Phil. (Oxon), F.Inst.P.

Professor of Experimental Physics, University of Sydney

"Have you guessed the riddle yet?" the Hatter said, turning to Alice again.

"No, I give it up," Alice replied; "what's the answer?"

"I haven't the slightest idea," said the Hatter.

"Nor I," said the March Hare.

(From "A Mad Tea-party" in "Alice's Adventures in Wonderland," by Lewis Carroll.)

AMONG the different kinds of interference to which the reception of broadcast programmes is liable there is one which is more prevalent in Europe than elsewhere and which is known under one of the names: "the interaction of radio waves," "radio-interaction," or "the Luxembourg effect."

It arises when the wave to which the receiver is tuned is found to have in its background the programme of a distant powerful station which may possess a very different and unrelated wavelength.

The existence of this phenomenon was first reported by A. G. Butt in the issue of *World Radio* for April 28, 1933, where he stated that he had heard the programme of Radio-Paris (1,725m., 75kW) as a faint background when his receiver was tuned to Radio-Luxembourg 1,190m., 200kW), and that he heard this background *only* on Radio-Luxembourg's wavelength and *only* when this station was working.

This report was followed shortly after by one from Dr. B. D. H. Tellegen in the form of a letter, published in the issue of *Nature* for June 10, 1933, from which the first paragraph may be quoted as follows:—

"The coming into operation of the Luxembourg high-power broadcasting station on a wavelength of 1,190m. has caused the following remarkable phenomenon. For the first time, on April 10 of this year, it was observed at Eindhoven, Holland, that when a radio receiver was tuned to Beromunster (460m.) the modulation of the Luxembourg station could be heard in the background to such an intensity that during the weak passages of the programme of Beromunster the programme of Luxembourg was heard with annoying strength. Since the field strength of Luxembourg at Eindhoven has the quite normal value of about 10 mV/m. (the distance from Luxembourg to Eindhoven is somewhat more than 200 km.), and the same phenomenon was observed with different types of receivers, this cannot be due to cross modulation in the receivers. It was also observed with a battery set away from the electrical distribution system of the town, so that any disturbance influences from these sources were eliminated. Hence it seems that the phenomenon has its origin somewhere in the transmission between Beromunster and Eindhoven. It may be remarked that Luxembourg is situated nearly on the line joining Beromunster and Eindhoven."

Tellegen also stated that the same phenomenon had been observed at Eindhoven when receiving ten other stations whose wavelengths were included in the range 259m. to 1,725m. and whose positions lie somewhat in the line from Eindhoven to Luxembourg, and that it had not been observed on Langenberg (472m.), Brussels (509 and 388m.) or any British station.

AN authoritative account of the discovery of the "Luxembourg effect" in Europe and the development, by logical reasoning, in the Antipodes of a tenable theory to account for it.

Sometime about the beginning of August, 1933, a group of physicists was gathered round a tea-table in Professor Madsen's Department of Electrical Engineering at Sydney University discussing over their cups the remarkable phenomenon described by Tellegen.

The discussion gave no definite illumination, as it was generally agreed that the information in Tellegen's letter was inadequate for this purpose.

Theory of Wave Propagation

Some three months later one of them, in the official capacity of Examiner, was engaged in reading the thesis of another. Therein was a discussion of the fundamental equations governing the propagation of radio waves through the ionosphere, and quite properly the current orthodox assumption was adopted that the properties of the ionosphere are unaltered by radio waves. The Examiner was in hypercritical mood, perhaps the result of an excessive sense of his responsibility. As a result he discovered that when the waves from powerful radio stations like that of Luxembourg are considered the orthodox assumption was sufficiently wrong *to matter*. It then followed that this influence of a powerful station on the properties of the neighbouring part of the ionosphere might be observed by its particular effects on another radio wave which passes through the same part of the ionosphere. At this point it suddenly dawned on the Examiner that here lay the explanation of the phenomenon whose existence had been reported by Tellegen. Over the next morning's breakfast toast and coffee the Examiner mentioned this "brain wave" to one of his guests, a third member of Professor Madsen's tea-party, and invited his collaboration.

In this manner was born the theory of radio-interaction which was first published by Bailey and Martyn in the issue of *Nature* for February 10, 1934, p. 218. It is not without interest to quote the following extracts from their communication:—

"The phenomenon recently reported by Tellegen whereby the new broadcasting station at Luxembourg appears to interact with that portion of the carrier wave of the Beromunster station which is received in Holland can be explained by taking into account the effect of such a powerful station (200 kW and $\lambda = 1,190$m.) on the mean velocity of agitation u of the electrons in the ionosphere. Any change in u will produce a change in ν, the frequency of collision of an electron with molecules, and hence a change in the absorbing power of that part of the ionosphere in the vicinity of the station. Since this change depends on the magnitude of the electric vector in the disturbing wave, it follows that the absorbing power of this part of the ionosphere will vary in accordance with the modulation frequency of the station, and so the modulation will be impressed in part on any other carrier wave which may traverse this region.

"We have examined these points quantitatively with the help of data obtained by Townsend and Tizard on the motions of electrons in air, and have arrived at the following conclusion.

"The amount of modulation of a carrier wave produced by a disturbing station of power P and modulation frequency f is approximately proportional to P and inversely proportional to f. There is thus introduced a distortion of the original

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The Interaction of Radio Waves—

modulation, at the expense of the higher frequencies of modulation. . . .

"It is to be anticipated that the Warsaw station will also exhibit the effect in just appreciable intensity if careful investigation be made."

In the year 1913 Professor J. S. Townsend and Mr. H. T. Tizard, both of Oxford University, made an investigation on the motions of electrons in air, at low pressures and under the influence of electric forces, which yielded results of considerable importance to our knowledge of the nature of collisions between electrons and molecules. Their experimental methods were simple, and their reasoning was based on highly ingenious applications of the mathematical theory of probabilities of essentially the same nature as those used with much success by Maxwell and Boltzmann in the youth of the dynamical theory of gases. The three principal properties of electrons in air which Townsend and Tizard determined were, in effect, as follows:—

The *mean velocity of agitation* (or random motion) u of an electron under a specified electric force and for a given air-pressure; *the collision frequency* ν, that is the average number of collisions with molecules which an electron makes in one second; and the *collision loss* g, that is the average percentage of its own energy which is lost by an electron at a collision.

Electrons in the Ionosphere

Twenty years later these results were applied to the study of the motions of the electrons in the ionosphere under the influence of the electric forces produced by relatively strong radio stations; the train of reasoning runs as follows:—

The electric force acting on an electron, due to a radio wave (L), alternates in direction many times per second, and so in each cycle the electron both receives kinetic energy from the wave and also returns energy to it. If no molecules were present there would be no collisions to disturb the motion of the electron and these two energies would be equal, that is, the average velocity of the electron would be unaltered by the radio wave. But the presence of molecules results in collisions at which the electron loses some of its own energy, and then the energy received from the wave per cycle is greater than the energy returned to it. Thus, in the ionosphere an electron acquires an increase in energy, and so an increase in its velocity of agitation, when a radio wave passes through. The increased velocity causes the electron to meet a larger number of molecules per second, that is *an increase in the collision-frequency is produced by the wave* (L). The way in which the collision-frequency increases with the effective amplitude of the wave is illustrated in Fig. 1.

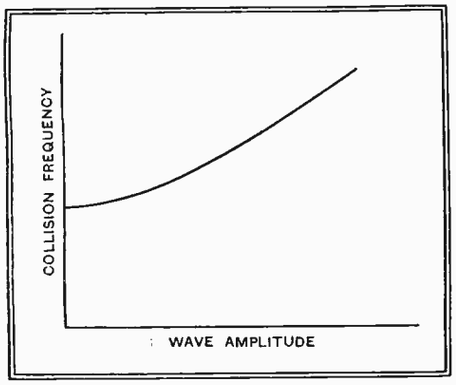

Fig. 1.—Collisions between electrons and air molecules increase in frequency when the radio-wave amplitude is increased.

Impressed Modulation

The bearing of this conclusion on the propagation of other radio waves through that part of the ionosphere which is influenced by (L) may now be studied. It is well known, as the result of the labours of Appleton and other investigators, that a radio wave (w) is partly absorbed in its passage through the ionosphere, and that the coefficient of absorption is nearly proportional to the collision-frequency; the latter conclusion is a result of the same process as that discussed above, namely, during a cycle the wave imparts more energy to an electron than it receives from it. Consequently when the collision-frequency is increased by the first wave (L) the second wave (w) suffers increased absorption and so is received weaker at the ground. If the amplitude of (L) be varied rhythmically, at some frequency F in the audible range, then the amplitude of the wave (w) as received must also vary with the same acoustic frequency F; in other words, *the modulation of the wave* (L) *is impressed on the wave* (w).

In this way, by a process of deductive logic, we conclude that an interaction between two different waves traversing the same part of the ionosphere is a *necessary* consequence of the results established by Townsend and Tizard on the one hand, and by Appleton and his associates on the other.

Had an apparent radio-interaction not already been observed by Butt, Tellegen and others, it would nevertheless have become an urgent necessity to verify its existence as revealed by the above-sketched train of reasoning. But in order to identify with some confidence the *observed* interaction with that predicted theoretically it is necessary to compare as much as possible the different characteristics of the observed interaction with those of the theoretical interaction. The problem of identification is similar to that involved in tracing a person wanted by the police with the help of a description or photograph of this individual. We therefore now proceed, so to speak, to give the height, complexion, finger-prints, etc., of Mr. Radio Interaction, and later for the purpose of identification we will consider the various reports made by those people who believe that they have come across him.

The first characteristic indicated by the theory[1] is that the modulation impressed by the station (L) on the wave (w) is proportional to the *power* of (L) and that consequently the interaction is most easily observed when it is caused by a powerful station like that at Luxembourg or Warsaw.

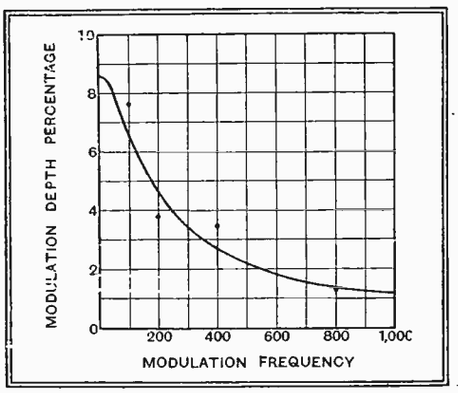

Fig. 2.—Calculated curve showing that the impressed modulation should be distorted in favour of the low frequencies. The dots represent experimental results.

Secondly, the interaction is most easily observed when that part of the ionosphere at which the wanted wave (w) is reflected lies within a circle concentric with (L) and of radius about 200 to 300 kilometres.

Thirdly, the depth of the modulation impressed on the station (w) is proportional to that of the interfering station (L).

Fourthly, the interaction in European latitudes is most easy to observe when the interfering station (L) has its wavelength at the *long end* of the broadcasting waveband, and is very difficult to observe when the wavelength of (L) is less than 200m.

Fifthly, the depth of the modulation impressed by a station similar to Luxembourg under favourable conditions *exceeds* 0.3 per cent. of the modulation ordinarily present in the wanted wave (w), that is, there should be a *perceptible* background.

Sixthly, there is a notable distortion of the impressed modulation, and this distortion favours the low notes of a musical programme or speech broadcast by (L). The actual manner in which the depth of the impressed modulation M varies with the frequency F of this modulation is illustrated by the curve in Fig. 2; this curve corresponds to the formula—

$$M = \frac{1065}{\sqrt{F^2 + 15400}} \text{ per cent.}$$

If the station (L) emits Morse signals each dot or dash should be observed to die out more slowly than usual.

Some other characteristics are also predicted by the theory, but these will be given farther on.

In the next section we will compare the characteristics predicted above with those actually observed.

(To be concluded.)

[1] For a full account of the theory, reference may be made to the publication of Bailey and Martyn in the *Philosophical Magazine* for August, 1934, page 369.

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The Listener and the Law

LICENCE AND COPYRIGHT QUESTIONS

By A LEGAL CORRESPONDENT

THERE are many listeners who may wonder why they are compelled by law to take out a yearly licence for their receiving-set. They would probably admit at once that they get better value for this particular 10s. than for any twenty shillings spent otherwise, but they feel rather strongly that the charge which is levied should be paid direct to the B.B.C. Why, they ask, does the P.M.G. take a rake-off?

In common law the possessor of land owns the subsoil as far as he can dig down, and has a claim to the space above for as high as he likes to build—and possibly higher. If, then, wireless waves are sent across his holding and are caught upon his aerial, why must he pay for a Government licence before he can make use of them?

The answer is that the Postmaster General enjoys a long-standing monopoly of all forms of communication. This originally meant that he had the sole right to carry the mails, but Parliament has since extended it to include not only the use of the telegraph and telephone, but also the sending of messages by wireless through the ether. It follows that the B.B.C. must by law secure the permission of the P.M.G. before they can use the ether to transmit their programmes, and the listener is similarly bound by the Wireless Telegraphy Acts to be licensed before he can receive them. As State guardian of the ether, the P.M.G. is entitled to extract some profit from its use, though the amount is, in practice, settled more or less amicably between his Department and the B.B.C., keeping, of course, an eye to the general interest of the public they both serve.

But the P.M.G. licence is not the only "legal permission" that is required to run the broadcast service. If the programmes are to have any flavour of interest, the question of copyright must necessarily come into the picture. It has, in fact, raised a host of delicate legal problems.

In the first place, it will perhaps be admitted that the author of a play, or the composer of an opera, or piece of music, or the writer of the words of a song, is as much entitled to be paid for his work as any other man. He may love his art but he has to meet his living expenses like the rest of us. Original work, however, is easily copied or pirated, and the law of copyright protects the author from this form of theft by giving him the sole right of reproduction. In other words it allows him to recover damages against anyone who uses his work without permission.

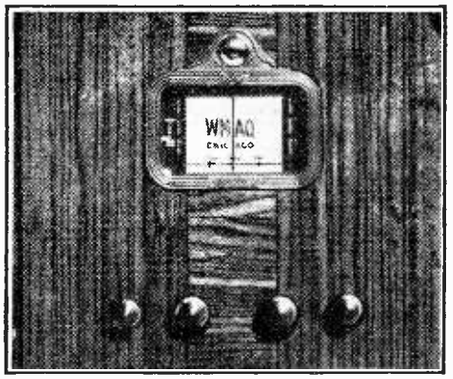
Now copyright can either be sold outright, or it can be disposed of in what might be called fractional parts. For instance, the author of a work of fiction can sell the serial rights, the book rights, the dramatic rights, foreign rights, and so on, separately, and to different people. In this sense copyright resembles land, on which various kinds of leases can be granted, rather than the more ordinary kind of property, such as a watch or motor car, the ownership of which passes outright by sale.

When the B.B.C. wishes to include any copyright work in its programme, it must therefore first get permission to do so from the author. Obviously it does not want to purchase the whole copyright, but only to pay a fee proportional to the use which it is to be made of the work. In practice the author fixes a sum which is based on an understanding that the broadcast transmission is intended only to be received by listeners in their own houses. That is to say it is for "domestic or private entertainment only."

A Test Case

Some two or three years ago a case was fought in the High Courts to determine the position when B.B.C. programmes were reproduced in a restaurant or hotel, or, in fact, in any public place—as distinct from the listener's own domestic circle.

It was argued by counsel that the permission given to the B.B.C. by the owners of copyright did not cover the reproduction of their works in public. That an extra profit, either direct or indirect, came to the owner of the hotel, restaurant, or other public premises in which the reproduction took place, and that in such circumstances it was only fair that the owner of the copyright should be given a share of this profit in the shape of an extra fee.



VISUAL INDICATION. An American tuning system whereby the call-sign of the station to which the receiver is tuned is projected on to a screen. The projector works with a small circular film on which the call-signs are printed. The vertical line on the screen gives an indication of accuracy of tuning, resonance being indicated by minimum width.

The courts agreed with this view. They held that the permission given by the owners of copyright did not include the right to a "public" performance but only to a private or "fireside" one, and that those who want to give loud speaker or PA reproduction of the broadcast programmes in hotels, cafés, and restaurants, must pay an extra fee for the privilege.

The Performing Right Society, who fought the action on behalf of copyright owners against the Hammond Brewery Co., now issue special licences to cover "public" reproduction, at a rate which varies according to the size and nature of the premises concerned. Their licence covers the author's copyright on works which are either broadcast or reproduced from a gramophone record.

Another interesting point, pretty much on all fours with that just discussed, has since arisen in connection with the direct use of gramophone records in private and public.

The Copyright Act of 1911 states that "Copyright shall subsist in records and other contrivances by means of which sounds may be mechanically reproduced in like manner as if such contrivances were musical works." Although it is clear that a composer must be protected against any unauthorised reproduction of his work by means of a gramophone record—in other words that the maker of the record must pay him a fee for the privilege or recording his work—the law now goes a step further.

In an action brought by the Gramophone Co. against Stephen Carwardine, Mr. Justice Maugham laid it down that skill, both of a technical and artistic kind, is exercised in the making of the record itself. Apart from the author's copyright, and the dramatic copyright of the artist who performs before the recording instrument, the maker of the record creates a new and independent copyright by the skill he displays in arranging the acoustics of the studio, and in otherwise ensuring an artistic embodiment of the work by the mechanical recording apparatus.

This last form of copyright is legally vested in the maker of the record, after he has, if necessary, acquired the author's copyright. It then gives the maker power to lay down conditions as to how his record shall be used. Actually, in the legal action mentioned, the makers established their copyright in the record of an opera called "The Black Domino," which dated back a hundred years, so that the original composer's rights had long since expired.

When an ordinary customer buys a gramophone record, the price he pays for it merely covers the right to use the record in his own home, "for domestic and private entertainment only." It does not include the right of reproduction in a restaurant, hotel, or other public place. For this, special permission must be obtained from the Phonographic Performance Co., who charge a yearly fee, ranging from half a guinea upwards, according to the nature, rateable value, and seating capacity of the premises in question.

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Broadcast Brevities

NEWS FROM PORTLAND PLACE

Empire Transmitters

WORK on the new Empire transmitters at Daventry is proceeding so rapidly that there is every hope of completion in time for the use of these transmitters in connection with the Coronation broadcasts. Thus four years of experiment on the old 5XX site will culminate in the inauguration of a new era in Empire broadcasting, coinciding with an important phase in British history.

Gain in Signal Strength

Actually, the two existing Empire transmitters are being converted into one high-power transmitter, while two entirely new high-power transmitters are being built. These will be capable of a maximum aerial power of 100 kilowatts. The real gain in signal strength in the direct line of transmission will be achieved by narrowing the beam—an angle of twenty degrees on either side of the centre line instead of approximately thirty-four degrees covered under the old aerial system. The twenty-five aerials which are included in the scheme will be constantly employed, as more of them are required to cover the same area, but with a stronger signal.

Strengthening Bonds of Empire

The suggestion that the B.B.C. is "replying" to any foreign "challenge" in perfecting the Empire transmitters should not be given undue importance. The primary object is to increase the prospect of linking up the Empire and consolidating friendly relations throughout the British Commonwealth of Nations.

One System : Two Studios

TELEVISION production difficulties are already appreciably lessened by the introduction of single-system transmission at Alexandra Palace. Although not wired for the job the former Baird studio is now used for quite a number of programmes, which are carried out as "O.B.s." In other words, they are directed from the M-E.M.I. control room, communication being effected by co-axial and sound cables taken through the main corridor.

It would have been difficult, if not impossible, to stage such an elaborate "set" as that used in "Casino" last week if the television talk in the same transmission had been carried out in the same studio.

In "Casino," which was produced by Harry Pringle, there were eighteen tables, a cocktail bar, a dance floor and a bandstand, not to mention yards and yards of spaghetti.

Transatlantic Tests on "Ultra-Shorts"

VIEWERS who switch on their sets at odd hours of the day outside the normal transmission periods are often rewarded by interesting sights and sounds. Indeed, those of a speculative turn of mind might start a book, laying varying odds on whether the station is "on the air" or not at different times of the day.

Those who were tardy with the switch last Friday will have seen, soon after 4 o'clock, the repetition of the afternoon programme for the purpose of an anti-interference demonstration by the British Electrical and Allied Industries Association.

In the previous week announcements were transmitted on the sound wavelength every afternoon at 4.15, following a request from the Radio Corporation of America. Officials of the Corporation had received reports that "Ally Pally" had been picked up in New York State, but so far there have been no confirmatory reports.

More Trouble in Wales

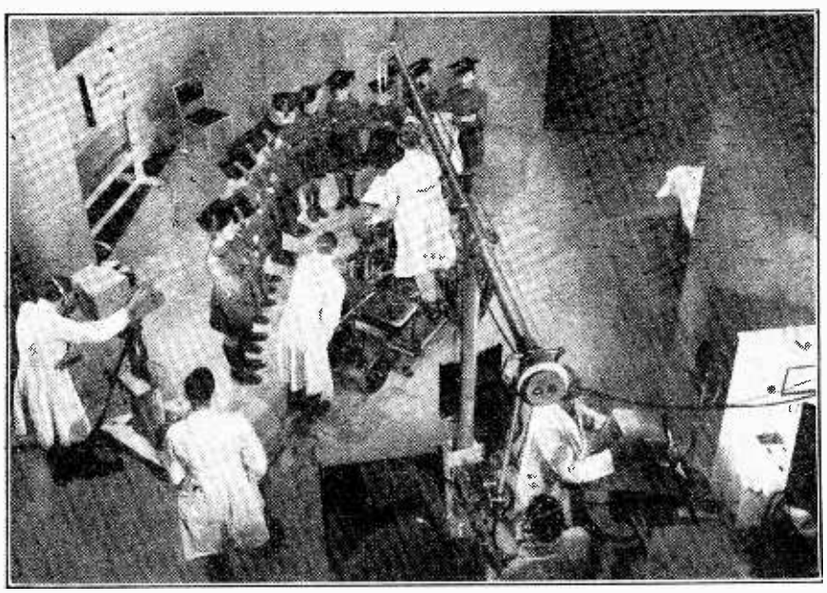
WALES is still seething over the Penmon - Beaumaris controversy. It will be remembered that while the Cambrian purists were wrangling over whether the new B.B.C. transmitter should be known as "Boh-maris" or "Bewmaris," the Corporation solved the problem by deciding on Penmon.

Now, it seems, the "Boh's" and the "Bew's" are fiercely united in an effort to wipe Penmon from the map; but the B.B.C. sticks to its guns by declaring that the new transmitter is at least twenty yards inside the boundary of Penmon parish.

By the time these lines are read, a strong frontier guard will probably have been established and "incidents" may be expected almost hourly.

Sir John Reith for Australia ?

NOT long ago, at a select little dinner party, Sir John Reith, who has already visited "S.A.," expressed a wish to see Australia, and Mr. Stanley Bruce, the Australian High Commissioner in London, immediately responded with a hearty invitation. But there the matter rests at present.



TELEVISION—THE PICTURE PAGE.

A scene inside one of the B.B.C. television studios during the presentation of a "page" in this popular feature. Each "page" is introduced by "the switch-board girl" from the television exchange, part of which can be seen on the right.

Stereophonic Transmission

RUMOURS that the B.B.C. is hard at work on stereophonic, or "binaural hearing" tests, should not be taken too seriously. A good deal of quiet work in this direction is in progress, but the experiments are still not beyond the laboratory stage.

Coronation Radio Drama

FOR the quarter of the year which embraces the Coronation period, Val Gielgud, no longer B.B.C. Drama Director, but now Director of Features and Drama, has arranged a comprehensive programme of plays. Top of the list will come one of J. M. Barrie's works, which has yet to be chosen. The noteworthy fact, however, is not the play's title, but that this will be the first occasion on which Sir James has allowed a full-length play of his to be broadcast.

Shakespeare with Orchestra of 119

Another big Coronation production will be "A Midsummer Night's Dream," in which the complete B.B.C. Symphony Orchestra of 119 players, under Dr. Adrian Boult, will take part. There will be an all-star cast, drawn from every branch of the entertainment industry.

A Mixed Bag

Before the Coronation, that is, in April, a "Sapper" story, "The Black Gang," will be produced by Lance Sieveking, and also that pathetic Victorian story by Mrs. Henry Wood, "East Lynne," produced by Laurence Gilliam—one might almost call this a blending of medievalism and modernity. For Eugene O'Neill's play, "The Emperor Jones," towards the end of May, the producer will be Peter Creswell.

Some Notable Titles

In June, listeners are to hear Galsworthy's "The Silver Box," a Barbara Burnham production, and "Youth at the Helm," a revival of Griffith's adaptation of the Vulpius play. Peter Creswell will produce "Julius Cæsar" in the same month, while Val Gielgud will be responsible for "Atmospherics," by Lord Dunsany. Four other notable plays which will wind up the April-June quarter will be "The Purple Pileus," by H. G. Wells; "Autumn Violins," by Sourgutcheff; "The Man in the Iron Mask" by Dumas; and G. K. Chesterton's "The Man in the Passage." One of the shortest productions in the series will be Andersen's "The Shirt" (thirty-five minutes); the longest will be "A Midsummer Night's Dream," which is to run for two hours.

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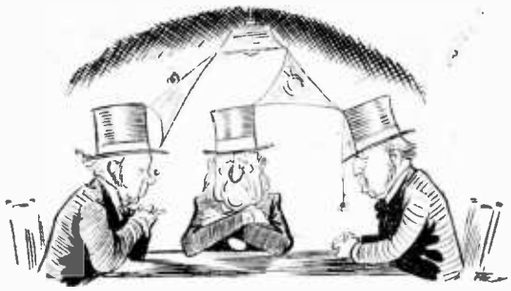
UNBIASED

By FREE GRID



The Old Brigade at Broadcasting House.

The Cinevisor

I SEE that my old cell mate, "Diallist," has been moaning about the small size of the picture received on the ordinary television receiver. He seems to have forgotten that he and I thrashed the matter out very thoroughly some time ago just before he earned his remission and went out on ticket-of-leave, for I notice that he omits the most cogent arguments against the present picture size which averages 12in. × 9in. or thereabouts.

He quite rightly points out that in scenes where a considerable number of people are shown the figures are too tiny for details to be brought out properly, and that we need something about the size of the average home ciné screen. He omits to mention, however, that the fact of the picture being so small compels people to sit very close to it, which means that the adjacent loud speaker is bellowing right up against their ears, a disadvantage which, as I have previously pointed out, makes itself felt even in the case of the ordinary set which, in the absence of remote tuning control, you've got to have close up against your armchair in order to eliminate the necessity of having to keep on jumping up to change the programme. Furthermore, owing to the small size of the picture, it is impossible for many people to see it simultaneously, a disadvantage which will make itself increasingly felt now that we are returning to the large families of the dear old Victorian days.

Me and my old cell-mate "Diallist."

The real argument brought forward by the protagonists of the present size is that it is just big enough for the home and that any larger size would cause us to get a crick in the neck like sitting in the front row of the cinema. This is all eye-wash, of course, and is merely used to cover up the fact that a larger size is at the moment a technical impossibility, or at any rate very nearly so. The ideal size for the home is undoubtedly that of the home cinema, which is 30in. × 22in. in the case of the smallest screen on the market (nursery types excepted). This is the size which I feel sure will eventually be adopted, but we can hardly expect the cathode-ray tube to be made with a screen of that size, and so it appears obvious that eventually we shall use a *projected* picture as in the case of the home cinema.

At present, of course, a projected picture as demonstrated in certain cinemas is far too coarse for home use, but this difficulty will be overcome sooner than most people anticipate, for I am intending to give my personal attention to the problem. Furthermore, my apparatus is to be arranged on the radio-gramophone principle, so that if you get tired of the B.B.C.'s programme you can shove on your own talking film. I think I shall call it the "Tele-cinegram," or something like that.

An Official Remembrancer

SEVERAL readers have written in to ask me if old age is overtaking me and causing me to weaken, as in their letters they point out several historical inexactitudes and chronological inaccuracies which have occurred in the B.B.C.'s programmes recently and which they presume have escaped my notice. Although I am certainly not so young as I was, this is not the reason for the apparent oversight on my part. I've noticed the errors all right, but the B.B.C. make the whole game too easy, so that it is rather like taking toffee from a child, and if I am not very careful I shall get the R.S.P.C.C. on my track. I am, therefore, thinking of merely publishing a tabulated weekly list of their errors.

There is, however, one thing that is troubling me very seriously and causing me to lose quite a lot of sleep, and that is the question of the important broadcasts that are to be given on Coronation Day. After all, if the B.B.C. can be a whole month out in the case of something that recently happened—as they were when giving the date of their own running commentary on the Crystal Palace fire the other day—they are liable to be much more in error when arranging for broadcasting a future event where even a slight miscalculation of time would be fatal.

My qualms are caused by persistent rumours which are reaching me that the B.B.C. have got it firmly into their heads that Coronation Day is fixed for June 28th instead of May 12th, and are making their plans accordingly. The reason why they have got this particular date into their heads is, I understand, that June 28th was the date in 1838 when Queen Victoria was crowned—and some of the Old Brigade at Broadcasting House have not yet realised that the event is now past history. I really am very worried about it, and I do think that the B.B.C. ought to seize the opportunity to appoint an official remembrancer to their staff before some terrible catastrophe, involving international complications, occurs as a result of the unfortunate mental disability from which the programme staff seem to suffer. I am open to consider offers.

Painful Anachronisms

I AM surprised to see that several prominent wireless manufacturers—to say nothing of the more obscure ones—are still shouting the odds, in their advertisements, about their 1937 receivers. Surely this betokens a singular lack of go-aheadedness on their part. In other countries 1937 merchandise is long since a thing of the past and they are concentrating on their 1938 models. To realise this it is only necessary to glance at the advertisements in some of the journals circulating in that land of enlightenment and progress beyond the Atlantic, in some parts of which they are so go-ahead that even 1938 is past history.

Even in this old and staid country there are instances of this sort of thing. If, for example, you possess a horse, you will find it quite impossible to enter it for next year's Derby, let alone this year's one, as I have just found to my cost.

But still, I suppose we mustn't grumble too much, as manufacturers are showing very definite signs of getting a move on in the matter of improving the outside as well as the innards of their sets. I am glad to note that there is an ever-increasing tendency to adopt the horizontal type of cabinet for table sets rather than the stereotyped vertical pattern which was copied from America way back in 1931. To my mind the horizontal type is much more artistic, and looks far less out of place and top-heavy on a table, quite apart from the fact that it is more suitable for supporting beer bottles, ash trays, and similar necessities of life.

There is, however, one thing that I definitely do not like, and that is the increasing tendency to use very highly polished and over-ornamented cabinets, after the style of the horrible chiffoniers and whatnots in the days of the dear old Queen. This tendency is almost as bad as the ugly super-modernistic style, with its geometrical severity and bareness.

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New Apparatus Reviewed

Recent Products of the Manufacturers

BULGIN WAVEBAND SWITCHES

IN the first-introduced models of the Bulgin five-way double-pole switches a momentary open-circuit was allowed between adjacent contacts in order to allow for circuit connections in which a difference in potential existed between contacts.

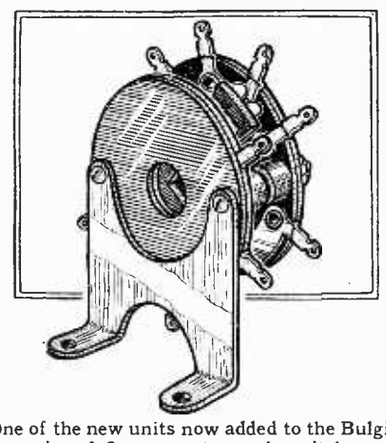
These switches have now been augmented by two new models in which double-finger springs are fitted on the rotor and arranged so that the adjacent fixed contact is engaged before the rotor spring leaves the previous one.

The new pattern is intended for use in circuits where no difference in potential exists between adjacent contacts, and especially to avoid leaving a grid circuit, for example, momentarily open-circuited on changing from one waveband to another or from radio to gramophone.

The continuous contact arrangement also makes for silent operation and eliminates clicks and other noises in circuit switching.

Two new models are now available in this pattern; one is a double-pole five-wave switch, which, incidentally, has a slightly lower capacity than the earlier models, since the rotor springs are arranged to connect like pairs of contacts on the two plates and not diametrically opposite pairs on the same plate as in the other types. This switch is known as the S159 and costs 2s. 3d. With a fixing bracket its price is 2s. 6d.

The other new model is the S167, or S168 with fixing bracket, and in this switch each plate carries five contact points and one continuous strip contact, and the switch is a two-pole five-way selector switch, since the moving contact is always joined



One of the new units now added to the Bulgin series of five-wave two-pole switches.

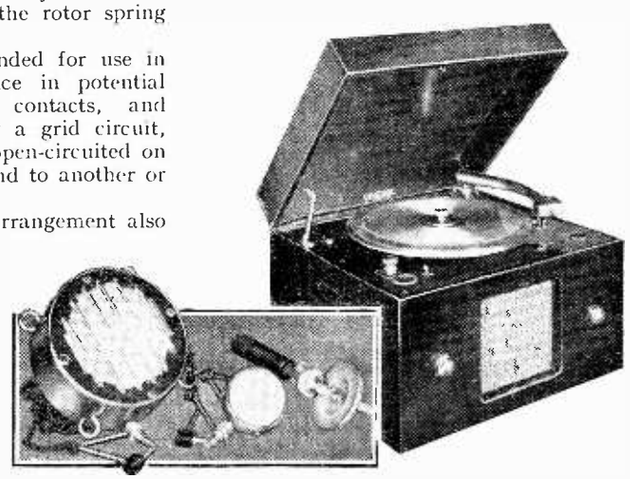
to the same point in the circuit. This model costs 2s. 3d. plain and 2s. 6d. with bracket.

These two new switches possess the same good features as the other Bulgin switches of the series, namely, self-cleaning contacts and robust construction, and they are extremely useful additions to the range. They, of course, fit the same drive and locator mechanism as the other switches in the series.

The makers are A. F. Bulgin and Co., Ltd., Abbey Road, Barking, Essex.

RECORDING GRAMOPHONE

LINGUAPHONE, LTD., 24-27, High Holborn, London, W.C.1, have introduced a table model Recordiogram which



Linguaphone table model recording gramophone, large and small microphones and thorn needle sharpener.

is a complete self-contained home recorder and electric gramophone. It embodies the special turntable, or one that in external appearance is the same, as that reviewed in *The Wireless World* of January 3rd, 1936. There is also contained in the cabinet a two-stage amplifier and a loud speaker.

The equipment is so designed that a rapid change can be made from recording to play-back conditions, and apart from changing the needle in the pick-up all other changes are effected by switches.

For recording specially prepared aluminium discs are used. These are comparatively soft and, unlike the majority of home-recording discs, are not cut, as no swarfe is removed by the needle, which only makes an indentation in the surface of the disc. Immediate play-back can be effected by setting the switches in the appropriate position and changing the special recording needle for a thorn-playing type.

A simple but very practical traversing mechanism is used, a feature of interest being that it is almost impossible to damage the threads on the traversing screw and driving arm, since the latter is faced with raw hide in which the lead screw will cut a new thread should it be damaged by accidental mishandling.

Good records have been, during the period of test, made from a standard radio receiver, as no more power than that required for good loud speaker reproduction in a room of average size is needed. Alternatively, a microphone can be used, and the makers have available two models. One is for mounting in a stand and costs 3 guineas, while the other is a small lapel-type, the price of which is 2 guineas. Both are high-grade models, and our tests show them to have good speech-frequency characteristics. The polarising voltage for the microphone is supplied by the amplifier.

The amplifier, which has a pentode output valve, provides adequate gain for microphone recording without being operated at maximum output. A tone control is also included.

Recording discs are available in 6in. and 10in. sizes; the former cost 5s. a dozen, while the latter cost 10s. a dozen, and both sides are prepared for use.

Between fifteen and twenty records can be made with one of the special needles, and these cost 1s. for two. Thorn playing needles are obtainable at 1s. for 10, and a useful needle-sharpening tool can be obtained for 3s. 6d.

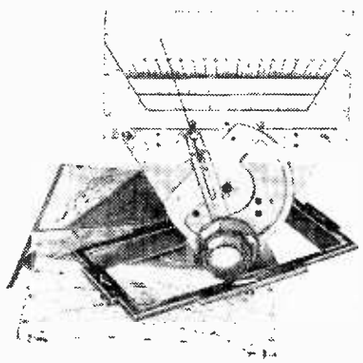
The price of the Recordiogram unit, which is AC operated, is 24 guineas.

WAVEMASTER CONDENSER DRIVE

THE latest pattern condenser drive supplied by the Webb Condenser Co., Ltd., 34, Hatton Garden, London, E.C.1, is a dual-ratio model, the main drive having a reduction of about 8½ to 1, and the slow motion, which is more in the nature of a vernier control, gives a 100 to 1 reduction.

The dial is well made and should prove very useful in all-wave sets where a very slow motion control is needed for the short-wave bands.

A feature of interest in connection with this drive is that the scale is detachable, and any one of several different styles of scale can be fitted. There are scales available with graduated divisions or, alternatively, scales with station names in their correct order and position can be supplied.



Wavemaster dual-ratio condenser drive and a selection of interchangeable scales.

Fitted with a graduated scale, lamp-holders, and including a moulded escutcheon plate, the price is 7s. 6d. Replacement scales with fixing brackets cost 1s. 6d. each.

HARTLEY TURNER GA12S AMPLIFIER

OWING to a misunderstanding, the Hartley Turner GA12S amplifier mentioned in our recent review of PA equipment was not the latest model. In the new version the frequency response has been improved at the higher frequencies, especially between 12,000 and 15,000 c/s. An output transformer for matching any loud speaker between 3 and 20 ohms impedance is now fitted, and a separate 4-volt 5-amp. LT winding has been added to the mains transformer.

The price of the new model GA12S amplifier is now £15, including valves.

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Listeners' Guide

Outstanding Broadcasts at Home and Abroad

THE many listeners who were unable to hear the breakfast-time broadcasts of the Test Matches because their work necessitated them leaving home before 8.20, will be pleased to hear that arrangements have been made for the broadcasts on the fifth Test Match at Melbourne to be given a half an hour earlier, at 7.50 a.m. The same procedure as for the last Test Match will be followed, there being a ball-by-ball account by Victor Richardson of the last ten minutes of the game, followed by Alan Kippax giving his usual résumé. As on previous occasions, a recorded version will be transmitted at 1 p.m.

LESLIE HEWARD, conductor of the B.B.C. Midland Orchestra, will conduct the City of Birmingham Orchestra at the Birmingham Town Hall on Thursday. Part of the concert will be broadcast Regionally from 7.30 to 8.25.

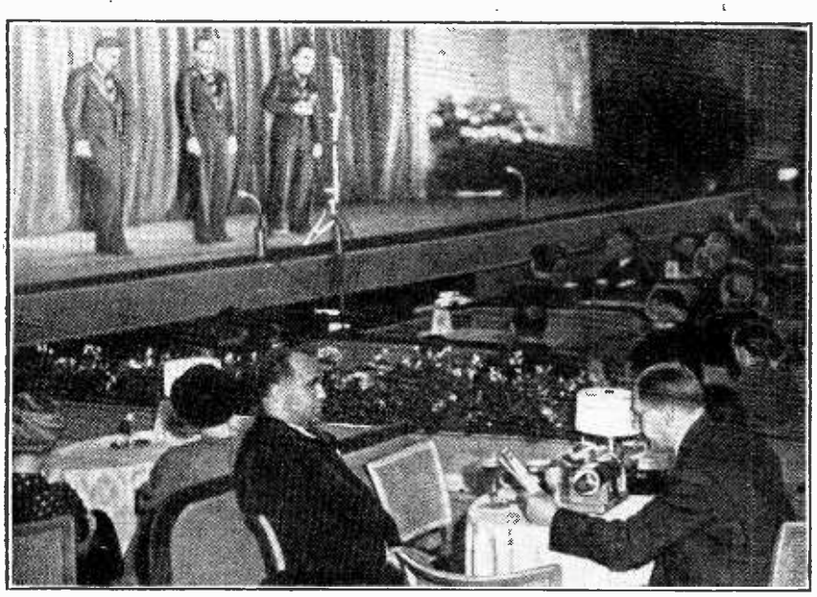
MONTHLY REVUE

THE trend of modern revue is to have a central theme, such is the case with "The Time of March," a revue which will be broadcast late in the evening, at 10.25 (Nat.), on Monday, and will be a sophisticated and topical affair on the lines of previous monthly revues. The central theme will be left for listeners to guess.

The cast will include Hermione Baddeley, Hermione Gingold, Eileen Hunter (the singing mannequin), Patrick Waddington, and The Radio Three. The music is by Jack Strachey and the book by Archie Campbell, who is also the producer, with additional lyrics and music by various authors and composers.

BRANSBY WILLIAMS

FOR many years Bransby Williams has been a front-rank radio artiste, his material and diction always being superb. On Monday, at 6.40 (Nat.), he will again be heard in "Orange Blossoms," Sax Rohmer's famous Eastern story, followed by "Old 94 on Time." But perhaps the most interesting item of his broadcast will be his recital of Tennyson's famous "Charge of the Light Brigade," supported by the B.B.C. Effects Department and Reginald Foort at the theatre organ.



GERMAN O.B. When German stations give broadcasts from theatres the commentator, as shown on the right of this photograph, sits at one of the tables like any member of the audience. This picture was taken during a recent relay from the Europahaus, Berlin.

COMIC OPERA

THIS week Gordon McConnel will produce the ninth edition of "Comic Opera," which will include a slice of eighteenth-century low life from John Gay's "The Beggar's Opera." This was the first ballad opera and also the first opera of its period to deal with "thugs and flash molls."

Frederick Austin, arranger and composer of the score used in Sir Nigel Playfair's Lyric, Hammersmith, production, will himself introduce his well-known work to the microphone.

The programme, which will be broadcast at 8 (Reg.) and 9.40 (Nat.) on Monday and Tuesday respectively, will also include "Nautch Girl," by Edward Solomon, and "A 'G and S' Cocktail or Mixed Savoy Grill." This clever burlesque by Laurie Wylie and Herman Finck was first adapted for the microphone in a comic opera programme last year. This playful piece of leg-pulling aroused considerable controversy.

The cast of "Comic Opera" includes Gladys Parr, the operatic mezzo-soprano who makes her first appearance in this series; Garda Hall, the coloratura soprano who has starred in many broadcast programmes; Jan van der Gucht, hero of "A Waltz Dream" and several other studio operettas; Clive Carey, Dick Francis, Alma Vane and Fred Yule.

Alfred Reynolds will conduct the Theatre Orchestra and Revue Chorus. He is already well acquainted with "The Beggar's Opera," having conducted the stage production at the Lyric Theatre, Hammersmith.

ANTONY AND CLEOPATRA

SHAKESPEARE'S tragedy has not been heard by listeners since 1934, and for his forthcoming production Val Gielgud will use novel methods of presentation. The play, involving as it does many changes of scenes, requires in the broadcast version drastic simplification in order that any confusion may be avoided, and it will be the producer's problem and pride to achieve this with the minimum of text cuts.

A brilliant cast has been assembled for the broadcast on Sunday at 5.35 (Nat.), headed by Margaret Rawlings, whose theatrical work renders her appearances at the microphone few and far between, and Leon Quartermaine, another ever-popular star of the stage and radio. Lydia Sherwood should make an enchanting Charmian and Ion Swinley an ideal Enobarbus. Patricia Hilliard and Ronald Simpson will play Octavia and Octavius Cæsar respectively.

RETAILERS AND MANUFACTURERS

MIDLAND provides for the National programme three debates in the series "A Nation of Shoppers." The debate on Tuesday, at 7.30, will put the question, "Does the retailer give the manufacturer a fair deal?" The three speakers for the manufacturers will be Frank Murphy, who until recently was chairman of Murphy Radio; Joseph Gimson, of Worcester, in the china trade; and Herbert Buckler, of Leicester, hosiery and fashion trade. F. C. Hooper, the director of a well-known firm, will speak for retailers.

Details of the week's Television programmes will be found on p. 202.

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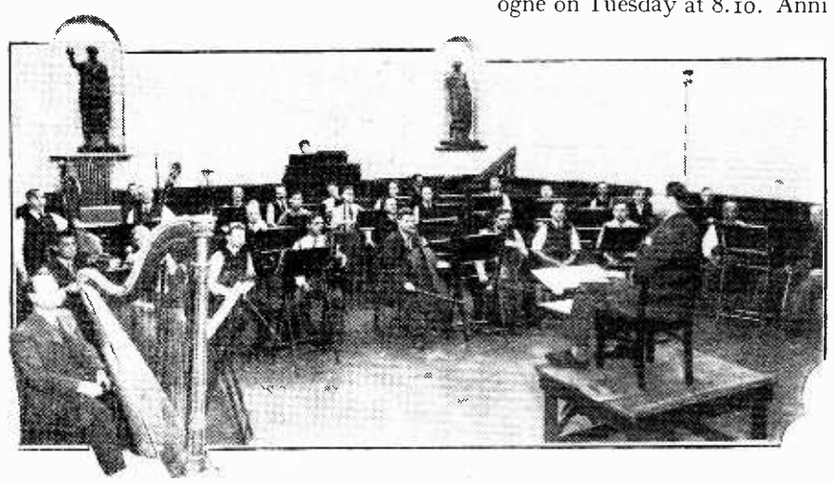
or the Week

MUSIC

CONSTANT LAMBERT will conduct the Sunday Orchestral Concert from a B.B.C. studio this week, at 9.5 (Reg.). The programme will include Balakirev's Symphonic Poem, Russia, William Walton's Symphony, and "The Walk to the Paradise Gardens" from Delius' opera "A Village Romeo and Juliet." This opera was first performed in Berlin in 1907 and for the first time in England at Covent Garden in 1910. "The Walk to the Paradise Gardens" is one of the most beautiful episodes in the opera and is characteristic of Delius at his best.

The brothers Adolf and Hermann Busch will play Brahms' Concerto for violin and 'cello at the Symphony Concert from the Queen's Hall on Wednesday, which will be conducted by Adrian Boult and broadcast at 8.15 and 9.25 in the National programme. There will also be included Schubert's great Symphony in C Major, now known as No. 9, and generally considered to be his finest symphony. It was composed during the last year of his life, 1828, although it did not receive its first performance until Mendelssohn conducted it at Leipzig ten years after the composer's death.



HUGO KRAMM and the Norwegian Wireless Orchestra of which he is permanent conductor. At 7.30 on Tuesday they will be heard from Oslo playing an all-Norwegian operetta, "Queen for a Day."

On Monday, at 10 (Nat.), Herbert Ferrers, the blind English composer, will conduct his setting of "Songs of a Roman Legion" by Rudyard Kipling. Other items in this all-British programme will be Leslie Woodgate's "Song of the Saracens," Vaughan Williams' "Songs of Travel," Roger Quilter's Suite "As You Like It," and German's "Henry VIII" Overture. Henry Cummings will be the soloist and the choral works will be sung by the B.B.C. Men's Chorus.

Helen Perkin will give a pianoforte recital in the National programme on Thursday at 7, consisting of Beethoven's Sonata, Opus 31, No. 3, and an Episode of her own composition.

OPERA

OUTSTANDING, as far as English listeners are concerned, in the week's opera is the relay in the Regional programme to-night (Friday), at 8.45, of Act 1 of Zoltán Kodály's "Székeleyfono" from the Royal Hungarian Opera House, Budapest. This evening shows very little more of this type of programme: probably Hamburg will attract many listeners to its 7.10 transmission of a studio performance of Auber's almost classic opéra-comique, "Fra Diavolo." Both stage and screen have conspired to keep this opera fresh in our minds—the lilt and grace of its songs strike our ears with renewed pleasure each time we hear them.

The inevitable Wagner comes on the air by way of Lille PTT, but we are not to have the pleasure of hearing a complete opera. The Conservatoire concert consists of excerpts from "Tristan and Isolde," and, as M. Inghelbrecht is responsible for the performance, with the National Orchestra playing, we can be certain of an excellent rendering. The two-hours' programme commences at 8.30.

The two opera programmes announced for Saturday evening are both public performances—at 8, Milan 1 relays, from the San Carlo Theatre, Naples, Giordano's successful "Fedora," an opera based on Sardou's play of the same name, while at 7.55 Stockholm relays the second act from the Royal Swedish Opera House performance of Peterson-Berger's "Arnljet," Grevillius being the conductor. This will be a festival performance in honour of the seventieth birthday of the composer.

For listeners who miss the Friday transmission from Lille, Brussels II offers a substitute performance on Sunday of the same Wagner opera, "Tristan and Isolde." In this case, however, Act 1, recorded in its entirety, will be heard at 11.

RADIO OPERETTA

THE first performance of a radio operetta entitled "Anni the Waitress" comes from Cologne on Tuesday at 8.10. Anni is the waitress at an inn in a small German town; Arthur, who falls in love with her, gets a job in the same inn. A mystery surrounds them, for both are not what they appear to be. If you have a knowledge of German, listen in, and you will hear who they really are.

MOTOR ROADS

ANOTHER German programme which should prove interesting to German students comes from Berlin at 7.10 on Thursday. It is called "Towards the Two Thousandth Kilometre," and deals with the construction of the special motor roads which was started in 1933, of which 1,000 kilometres has already been completed. Special music has been written for this programme, which will last two hours.

THE AUDITOR.

HIGHLIGHTS OF THE WEEK

FRIDAY, FEBRUARY 26th.

Nat., 8, The Kentucky Minstrels. 9.20, "I Was There." 9.40, "Down Melody Lane": melodies of the past.

Reg., 6, Eddie Carroll and his Music. 6.45, Car Up-keep. 8.45, Opera Relay from Budapest.

Abroad

Kalundborg, 8, Excerpts from musical comedy "S.S. Oceania" from the Nørrebro Theatre.

SATURDAY, FEBRUARY 27th.

Nat., 2.50, Ireland *v.* Scotland: Rugger commentary. 8, Music Hall. 9.20, Ice Hockey commentary. 9.50, Fencing commentary.

Reg., 6, B.B.C. Military Band. 9, Clyde Steamers: Feature programme from Scotland.

Abroad.

Sottens, 7.40, Annual Soirée of the Société des Amis de Radio-Genève at the Kursaal, Geneva.

SUNDAY, FEBRUARY 28th.

Nat., 5.35, Antony and Cleopatra. 9.5, Paper Mills, feature programme. 9.35, Leslie Jeffries and the Grand Hotel, Eastbourne, Orchestra.

Reg., 5.45, "The Table Under the Tree." ¶Commodore Grand Orchestra.

Abroad.

Brussels II, 9, I.N.R. Symphony Orchestra.

MONDAY, MARCH 1st.

Nat., 6.40, Bransby Williams. ¶, It's Happening Now. 8.30, St. David's Day: Welsh Music.

Reg., 7.30, Cumberland programme. 8, Comic Opera—IX.

Abroad.

Warsaw, 9, Dutch Composers' Music. Concert by the Radio Symphony Orchestra.

TUESDAY, MARCH 2nd.

Nat., 7.30, Discussion: Does the retailer give the manufacturer a fair deal? ¶World Population. 9.40, Comic Opera—IX.

Reg., 6.40, From the London Theatre. 9, Variety from the Regal Cinema, Kingston

Abroad.

Paris PTT, 8.30, "Carnival Throughout Europe": National Orchestra with Darius Milhaud as solo pianist in his own "Carnaval d'Aix."

WEDNESDAY, MARCH 3rd.

Nat., 7.30, "Melody Out of the Sky," 8.15 and 9.25, Concert from the Queen's Hall. 10.25, "The Time of March": revue.

Reg., 8.15, Variety from Midland Regional. ¶B.B.C. Military Band.

Abroad.

Strasbourg, 8.30, Wagner Festival from the Palais de Fêtes.

THURSDAY, MARCH 4th.

Nat., 6.40, "Patriotism Ltd.": radio play by L. du Garde Peach. ¶Esta Stein and her Yiddish Chauve Souris Company. 9.20, Organ Recital: Joseph Bonnet.

Reg., 6, The Worthing Municipal Orchestra. 7.30, The City of Birmingham Orchestra. 8.25, "The Traffic Goes Round and Round": a century of wheels in revolution.

Abroad.

Kalundborg, 7, Wagner Concert from the Odd Fellows' Palace.

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The Tuned Circuit

ITS RELATIONSHIP TO OPIUM DENS, CHRONOMETERS, ETC.

By "CATHODE RAY"

IN one of his films Harold Lloyd appears as a puny individual plunged into a "rough house" in the underworld of Chinatown, like a new-born lamb among wolves. At the end of the scene he emerges unharmed, while the entire roomful of Chinese ruffians is strewn over the floor in immobile confusion. He has accomplished this seeming impossibility by a policy of utilising the strength of one half of the gang to oppose that of the other; his own insignificant muscle being employed merely as an unobtrusive exciter or detonator to touch off the fireworks and keep them lively.

This absurd scene nevertheless serves to demonstrate the principle of the common "tuned circuit" essential to every radio set.

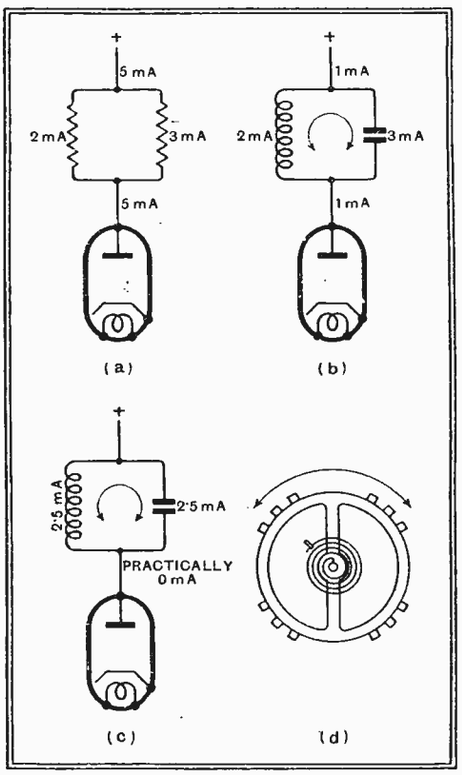
One often reads that when a circuit consisting of a coil and condenser is brought into tune it is equivalent to a high resistance. It thus acts as an efficient coupling for passing on "signals" of the right wavelength in amplified form, whereas signals of other wavelengths find either the coil or condenser an easy path which short-circuits them and so cuts them out. I have often felt that even if the reader has quite a good idea of how coils and condensers work, separately, and what inductance and capacity mean, this statement about them being equivalent to a high resistance must take a good deal of swallowing. The fact that in order to increase this equivalent resistance of the circuit it is necessary to *reduce* the resistance of the parts of the said circuit makes it all the harder to understand.

Knowledge without Tears

The merit of "popular" expositions of abstruse technicalities is that they enable the reader or listener to believe that he has grasped the meaning of something very difficult and hidden from his fellows. Thus when the structure of the atom is explained as a sort of planetary system of small balls revolving in orbits around a larger one he imagines he *knows* how atoms work. There is no subject, however recondite, that cannot be "learnt" in this way in an evening or two of reading a pleasant book. Having done so, one can even set up as an authority to teach one's friends. The new-laid expert wonders why other people sweat over dry textbooks and calculations. But looking at a picture of somebody is no substitute for years of personal acquaintance; nor does an illustration of a phenomenon, though well-chosen, make hard study unnecessary for a real understanding of it.

Certain highbrows affect to despise the popular analogy, but, personally, I never feel that I understand a thing satisfactorily, however fully it may be proved mathematically, unless I have also a clear mental picture of it.

So both popular analogy and mathematical proof have their place. The tuned circuit is a paradox—something apparently contradictory. It helps one to see where the catch is in an obscure paradox like this if an obvious paradox—one running parallel with the other in some essential respects—is displayed for comparison. The triumph of Harold Lloyd is a paradox; he was physically incapable of laying out a score of Chinamen, but yet he did it. The explanation is obvious—he obtained an equivalent effect by using his wits. The tuned circuit is a paradox that is not obvious, for it is remote from the commonplace experiences of life. But it bears some interesting points of resemblance to Harold and his Chinamen. A tiny signal current acts, and somehow it gives rise to relatively huge currents flowing through the coil and condenser. To sustain such currents in either component separately would demand far greater effort. But by cunningly setting off the characteristics of the condenser against opposite characteristics of the coil it is possible for a relatively puny effort to keep them going at it hammer and tongs for any desired length of time.



In a circuit, (a), consisting of two resistances in parallel, the current in the main line is more than that in either branch—it is, in fact, the sum of the two—so the resistance of the combination is lower than that of either. A coil and condenser are of opposite natures and keep on alternately exchanging current (b). The main line merely supplies the difference, so the combination is equivalent to quite a high resistance. If capacity and inductance of condenser and coil are correctly adjusted for current of the particular frequency concerned, (c), they are almost exactly equal and opposite in effects, and a very small current in the main line is able to keep a relatively large current surging backwards and forwards around the loop. The system reminds one of the excapement wheel of a watch, (d), which can be kept oscillating vigorously at one particular frequency by the application of very small impulses. One can trace a very exact and detailed relationship between the two systems.

Circuit Magnification

The result is a signal voltage much greater than that injected. If there were no loss of effort—the inevitable result of resistance—in either coil or condenser, the current in them, once set up, could be kept going on nothing. No current at all, when a voltage is applied from outside, means that the resistance of the whole is infinitely large. In practice there always is loss or resistance in the components; but if it is kept very small the resulting resistance of the whole system is very large. That does not imply that there is a large loss, because there can be none at all without current, and here the current is *very* small.

Suppose the tuned circuit is placed so as to amplify the signal emerging from a valve. A small signal current flows in the valve's anode circuit. If that current were made to flow through a coil *or* condenser a moderate voltage would be developed across it, depending on the impedance of the component. Signals of some frequencies would have less effect; others more. So selectivity would be more or less non-existent. The same would be true if an ordinary resistance were employed.

But if coil *and* condenser are used, connected as shown, they are to some extent complementary; when current is going into the one it is coming out of the other, and vice versa alternately. All that the valve has to do is to make good the difference between them. If, instead, they were a pair of resistances, and 3 milliamps. were flowing through one and 2 mA. through the other, the current supplied by the main line would have to be 5 mA. The resistance of the combination is lower than that of either separately. But a coil and condenser offset one another, and in similar

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The Tuned Circuit—

circumstances only 1 mA. need be supplied from outside. The object of tuning is to regulate the amounts of inductance and capacity so that they are exactly balanced. In practice it is possible for the current circulating backwards and forwards like an oscillating whirlpool between coil and condenser to be hundreds of times greater than that supplied. This, let it be repeated, applies only at the one frequency of resonance.

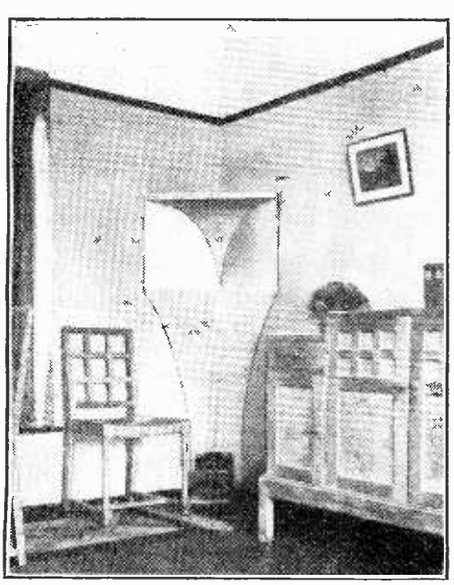
The whole arrangement has a very exact mechanical parallel in the escapement wheel of a watch. The hair-spring corresponds to capacity, and the inertia of the weights around the rim to inductance. Amplitude of motion is current. Friction is resistance. When the watch is going the wheel moves backwards and forwards in big sweeps, though the driving force is applied in relatively tiny jerks. This is possible only because at that particular speed of revolution the "capacity" and "inductance" of the wheel are equally and oppositely balanced. To use a radio term, the wheel resonates at the frequency that keeps right time. If the watch is slow or fast—that is to say, if the frequency to which the wheel is tuned is too low or too high—the tuning must be altered by adjusting the "capacity" until it is right. Friction is reduced to a minimum by mounting on jewelled bearings so as to avoid excessive loss when the wheel is in motion. Follow this analogy right through and you will understand tuned circuits better—and perhaps watches, too.

Voigt H.C. Horn

Simplified Design for the Home Constructor

IT is well known that a horn provides better loading than a plane baffle for the diaphragm of a moving-coil loud speaker—particularly at low frequencies. Not only is the over-all efficiency improved, but for a given sound output the horn requires a smaller movement of the diaphragm and there is consequently less risk of amplitude distortion.

Quality enthusiasts will be able to test for themselves the relative merits of plane and horn baffles with the home-constructor's corner horn made by Voigt Patents, Ltd., The Courts, Silverdale, S.E.26, as an inexpensive substitute for their domestic reflector-type corner horn. Although designed primarily for the Voigt moving-coil unit, for which horn loading is essential, it is capable of giving good results with units of other makes provided that the diameter of the diaphragm and also the volume of air it encloses are of comparable size.



Adequate loading of the diaphragm is achieved with moderate dimensions in the Voigt H.C. corner horn.

The H.C. horn is 5ft. 1in. in height and projects about 18½in. from the corner of the room. It is, therefore, much more compact than the 7ft. square plane baffle which would be required to give similar results in the bass. The unit is applied to a triangular aperture at the bottom, which is backed by a 45 deg. concrete reflector. Units with diaphragm diameters between 5in. and 8in. can be accommodated.

A series of tests was made with representative high-quality units, including the Voigt twin diaphragm. In all cases an improvement in bass response over that to be expected with baffles of the dimensions likely to be found in the average living-room was obtained. The effective cut-off for practical purposes we would put at 60 cycles. That is to say, on the oscillator the output appears to be maintained down to this frequency and then fades fairly rapidly, though there is still an appreciable output at 40 cycles.

Reproduction of Transients

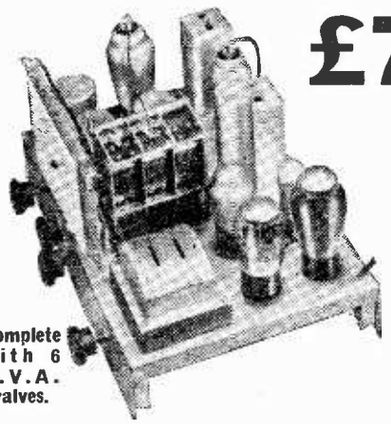
The high-note distribution, if not quite so wide as that of the domestic reflector horn, was in all cases more uniform than that of the unit mounted on a flat baffle.

The test was most instructive in bringing home the importance of magnetic damping, particularly for transient reproduction. From this point of view the Voigt unit was quite distinctive and there was no trace of flabbiness in the reproduction of incisive sounds to which some of the other units with comparable frequency ranges showed a tendency. The Voigt unit also appears to possess that rare faculty of giving adequate bass response for organ and orchestral music without investing the announcer's voice with a false depth of tone.

The price of the H.C. horn finished "in the white" is £2 15s., and we understand that blue prints are available for those who feel they would like to try their hands at constructing the horn for themselves. These prints are supplied free upon request to purchasers of the Voigt moving-coil unit; others may obtain copies priced 2s. 6d.

McCARTHY

new series better than ever —no increase in prices!



Complete with 6 B.V.A. valves.

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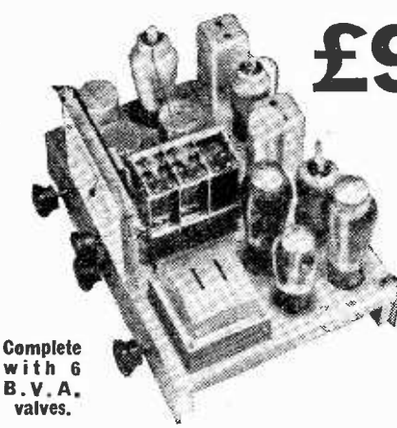
Revised specification includes many new refinements, at no extra cost. Heavy-gauge cadmium-plated steel-chassis. Iron-cored coils give still better performance. First-class workmanship and components throughout.

Brief Specification: 8-stage, all-wave band-pass superheterodyne, 7 tuned circuits. D.A.V.C. with "squelch" circuit valve and manual control for noise suppression. Illuminated "Airplane" dial. Octode frequency changer. Iron-cored coils. 3-5 watts pentode. Switching for gramophone pick-up. Wave ranges: 16.5-50, 200-550, 800-2,000 metres.



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"PUSH-PULL" ALL-WAVE SIX

6 valve all-wave superheterodyne with similar specification, performance, etc., to above, but with triode push-pull output giving 5½-6 watts. Illuminated "Airplane" dial with principal station names, tone control and volume control (both also operative on gramophone), full provision for gramophone reproduction.

A really high quality receiver, with exceptionally large undistorted output, and fine performance on all 3 wave ranges.

All McCarthy receivers supplied complete with valves, knobs, pilot lamps, leads, mains cable and plug. 12 months' guarantee.

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Random Radiations

By "DIALLIST"

More Mystery

RECENTLY I mentioned in these notes having heard a phenomenally strong and steady American station on the 19-metre band at times when relays from the U.S.A. were toward in this country. I enquired whether anyone had identified this station with certainty; I have not been able to do so myself since for most of this season I have done my short-wave listening by means of a variety of domestic "all-wave" sets whose calibration is naturally somewhat vague. I asked whether it could be W2XAD or some other station using temporarily increased power or a special directional aerial. Correspondents told me politely but firmly that I was talking through my hat: the B.B.C. always took in U.S.A. relays from W2XAD if using the 19-metre band; no special aerial was used; there was no increase in power. So emphatic were they that I had almost begun to doubt the evidence of mine own ears, when a letter came from a Southampton correspondent. This, though it confirms my experience of more than usually good short-wave reception during a relay, sets another hare afoot as regards the station responsible.

Not Too Easy

Here is what he says: "With my R.G.D. I generally receive W8XK on 19.72 metres reasonably well, but to-night (February 9th) I could at first only pull in a mushy carrier. At 9.30, when the B.B.C. began their 'Mardi Gras' relay from New Orleans, up came W8XK's signal strength, suggesting the use of a directional aerial or an increase in power. Soon after the American announcer had closed the relay, down went W8XK to a mushy carrier again." So far so good. But in the *Radio Times* the Mardi Gras relay was stated to be "in co-operation with the Columbia Broadcasting System," and, so far as I know, W8XK almost invariably radiates National programmes. And now for some further mysteries. The published programme for February 9th of W8XK (b) on 19.72 metres makes no mention of the New Orleans programme, but shows "The Home Forum" at 9.30 p.m. And Schenectady (a), that is W2XAD, is not shown as doing it either: "Concert Miniatures" is its 9.30 item! Nor is there any mention of New Orleans or Mardi Gras in the programme of W3XAL. A bit puzzling, what?

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Fair's Fair

I'M afraid I don't see eye to eye with the writer of a recent letter in the Correspondence columns of *The Wireless World* in defence of the kind of service man who diagnoses a perfectly simple defect in a receiver as something far more serious than it really is and goes to the length of charging for the replacement of components which he has never replaced. His point, you may remember, was that if the service man admitted that there was nothing wrong but a simple "dis," the owner of the set would object to paying a fair price for the job of resoldering, forgetting that the charge made must include the man's time, and so on. Really, I can't swallow that.

Tell 'Em What They're Paying For

Of one thing there can't be much doubt: the shop which makes exorbitant charges for doing straightforward jobs just isn't going to prosper. Surely by far the best way is to do what gasmen, garage men and other skilled traders do. They give you a bill which shows a charge for materials supplied and work done *plus* man's time. Thus a bill for a simple repair might read:—

	£ s. d.
To supplying one resistor and one fixed condenser ...	0 2 6
Service man's time locating and replacing faulty components	0 5 0
	0 7 6

Nobody in his senses could or would kick at that kind of thing, and the shop which gains a reputation for quick and reasonably priced service soon reaps its reward directly and indirectly. I should like to see all radio manufacturing firms offering a flat rate for labour charges during the guarantee period, in which they already undertake to replace faulty parts free. Too often these "free replacements" are accompanied by absurdly high charges for labour.

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Progress at the Gallop

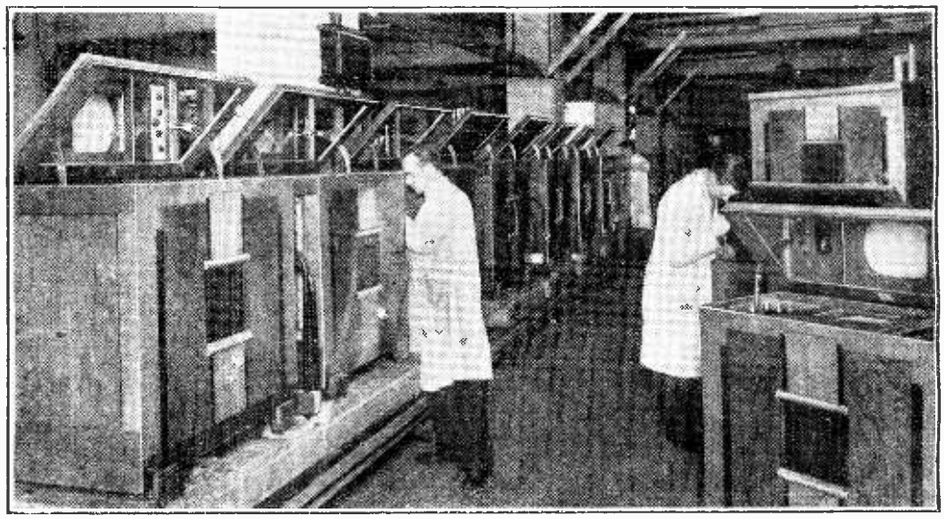
SO we did pass the eight-million mark for wireless receiving licences in January. And we didn't just creep up to it; we passed it at full gallop. The net increase for January was just under 111,000 as compared with 76,500 for the same month a year ago. Far from slowing down, the rate of increase has been speeding up during the last two years. In 1934 it was 565,000 in round figures; in 1935 rather over 592,000, and in 1936 nearly 593,000. The approach of the Coronation has been suggested as a reason for the 1936 acceleration, but I don't think that that had anything to do with it: it's still too far away. I'd put it down rather to the rapidly growing number of homes that have electric light. And there's one rather remarkable movement that is speeding up the electrification of houses.

Centrifugal Building

Wherever you travel by road or by rail in this country you can't help noticing the way in which cities, towns, townlets and even villages are tending to grow away from their centres. When I first came, nearly twenty years ago now, to the little country town in which I live it didn't cover much more than half the area that it occupies to-day. Its homes were more or less clustered round its market place and its one big street. In those years its population has remained almost stationary, but hundreds of new houses have been built where not so long ago there were fields of grass or roots or corn. Every single one of those new houses has electric light, and that means that a radio set can be operated at very low running costs. The superhet mains receiver, too, is now cheaper to buy than the simple battery set was a few years ago.

Sad, but True

It's rather tragic, in one way, that so many people were (and still are) frightened of the battery set by the bogy of high running expenses, which would never have existed had set makers and battery makers done a little tactful propaganda work and used some common sense. The public has been allowed to develop the belief that the small-capacity HTB is all that is needed for working any set. Some of us who write on wireless have tried for years to show the soundness of paying perhaps twice as much for a bigger battery that lasts four times as long; but ours have been voices crying vainly in the wilderness. We've had no backing by the trade. Results: (1) the battery set is looked on as being costly to run, though it needn't be, as I know from experience; (2) people are frightened of any battery set with more than three valves; (3) the battery set is regarded as something



The reduction in price of television receivers has been responsible for increased activity in the factory. Here is a large batch of H.M.V. sets being given a final check-over before dispatch.

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that must be vastly inferior to the mains set in performance, though this would never have happened had makers realised the possibilities of Class "B" and other things, with HTB's of adequate capacity. A pity, but there it is.

Interference Still a Menace

IN some places man-made interference with wireless reception is becoming less serious than it was. This is due partly to the hard work and the tact of G.P.O. officials who investigate complaints, and partly to the good sense and the neighbourly feeling of owners of interference-radiating apparatus when the trouble that they were causing (often without any idea that they were so doing) has been pointed out. That is just as it should be: if similar good will and thought for neighbours prevailed everywhere the interference problem would soon find its own solution. Unfortunately they don't, for there are heaps of localities in which interference is growing steadily worse, and in these I fear that nothing can be done until the spoiling of other people's reception is legally recognised as a nuisance and it becomes possible to obtain a remedy by giving the culprit formal notice to end it.

Revive the Pillory?

One idea occurs to me which might have excellent results were it adopted. Why not give the G.P.O. powers to publish in the local papers the names of offenders who have refused to fit suppressor devices to electrical gear that radiates interference? Can't you just see the effect of an announcement on something like the following lines?

"The undermentioned have been found by engineers of the G.P.O. to be causing interference with wireless reception in such and such a locality by the use of certain types of electrical apparatus. In each case the owner of the apparatus has been shown how and at what cost the interference could be ended, but has declined to take any action:—

A.B.C. Butcher, electric sausage machine Estimated cost £1 10s.
D.E.F. Hairdresser, trade appliances, Estimated cost £2 12s. 6d.
O.P.Q. Householder, domestic appliances, Estimated cost £1 15s. 6d.
X.Y.Z. Garage proprietor, Electric Motors, Estimated cost £2 17s."

If only it could be done that would bring quicker and more satisfactory results than actions in the courts. And really I don't see why it shouldn't be done. Do you? In most instances the mere threat of publication would be quite enough.

A Thought on Television

IT wouldn't surprise me a bit to see a good many television receivers appearing during the next few months at prices very considerably lower than those which now prevail. I only hope, though, that none of the numerous radio firms which are now contemplating an entry into this new field will try to give us the cheapjack television set. A piece of apparatus containing a variety of very delicately balanced circuits and involving voltages up to 3,000 needs to be really well designed and well made if it's not to be a source of trouble rather than delight. And over-cheap sets of indifferent performance and lacking in reliability might well prove a sad setback to the development of television just at the time when it needs every possible help and encouragement. We all want to see television becoming a popular hobby, but the way to that much-to-be-desired end is emphatically not through the cheap and nasty set.

News from the Clubs

The Southall Radio Society

Several interesting lectures have been given recently, including one on mast construction by Mr. Graham Fox, Ve3DG, followed by another on long-distance working by Mr. Leslie Wilkins, G6WN. Visitors are always assured of a hearty welcome at the society meetings, which are held every Tuesday, at 8.15 p.m., at the Southall Library, Osterley Park Road, Southall. The Hon. Sec., Mr. H. F. Reeve, 26, Green Drive, Southall, Middx, will be pleased to answer any enquiries.

The Golders Green and Hendon Radio Scientific Society

At a recent meeting of the society Mr. P. G. A. H. Voigt lectured on acoustic efficiency and described his early experiments with the horn-loaded loud speaker. This was followed by a demonstration of one of his own instruments. Although it was fed by only one PX4 valve, the volume obtained was a revelation to those present. Full details concerning the society can be obtained from the Hon. Assist. Sec., Mr. A. G. Griffith, Hornbeams, Priory Drive, Stanmore, Middx.

The Croydon Radio Society

One of the ever-popular G.P.O. lectures on electrical interference and its suppression was given recently by Mr. F. W. Newson. The number of complaints received from listeners by the G.P.O., stated the lecturer, has risen from 10,000 in 1932 to 40,000 during the past year. This great increase is presumably due not so much to the larger number of listeners as to the increasing spread of the knowledge that the G.P.O. is willing to help in cases of interference.

The loud speaker demonstration evening proved highly successful. Tests were given on B.B.C. transmissions and also on the signals of a local oscillator. After preliminary heats, four models succeeded into getting into the final, it being very difficult indeed to decide which was the best of these. Full details concerning the society will be gladly given to anybody communicating with the Hon. Pub. Sec., Mr. E. L. Cumbers, Maycourt, 14, Campden Road, South Croydon.

The Exeter and District Wireless Society

A lantern lecture on television given by Mr. T. D. Humphreys, A.M.I.E.E., was much appreciated by members. The lecturer emphasised the fact of the excellent quality of the accompanying sound broadcast owing to the wide range of frequencies transmitted. He pointed out that, although it is frequently said that frequencies above 10,000 c/s are not essential for good quality reproduction, a marked improvement is noticeable even on speech when frequencies up to 15,000 c/s are employed. The society holds its meetings at 3, Dix's Field, Southernhay, Exeter. The Hon. Sec., Mr. W. J. Ching, 9, Sivell Place, Heavitree, Exeter, will be pleased to answer all enquiries concerning the society.

The Harco Radio Club (Greenwich)

Mr. E. Cholot, of Lissen, Ltd., recently gave an interesting lecture, including a demonstration of several receivers manufactured by the firm. Members were surprised at the large number of American stations received on the short wavelengths. Meetings are held every Tuesday at 8 p.m. in the canteen lounge of G. A. Harvey and Co., Ltd., Woolwich Road, Charlton, London, S.E.7. The Hon. Sec., Mr. C. W. Kemp, will be pleased to answer all enquiries sent to him at Dept. H.R.C., 124, River Way, Greenwich, London, S.E.10.

They SHOULDN'T DO IT— BUT **THEY DO!**

THE whistle goes—the train moves — a final leap and Robinson has caught the 6.30 as usual. But at what a risk! Comfortably home he switches on his Radio, there's no warning whistle to tell him the speaker is 'dissed'—and he takes another risk... Then he fills in his guarantee form and the setmaker is blamed! But it's Robinson's carelessness that has let the high switching voltages do their deadly work.

You can't stop the Robinsons of life, but you can stop those surges, with T.C.C. Wet Electrolytics. Once fitted, switch on with the speaker dissed, the wrong transformer tapping used or even the pentode out, no harm can result. Surges are kept within check, and so are SERVICE COSTS!

FOUR TYPICAL TYPES

Type	Capacity	Continuous Working Volts
802	16 mfds.	440 volts Peak
602	8 mfds.	440 volts Peak
805	8 mfds.	500 volts Peak
809	32 mfds.	320 volts Peak

Special types are available to meet the stringent conditions found in A.C./D.C. Receivers. Write for full details.

T.C.C.

VOLTAGE REGULATING WET ELECTROLYTICS

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Letters to the Editor

The Editor does not hold himself responsible for the opinions of his correspondents

Contrast Amplification

APPARENTLY the writer of the letter published in your issue of January 1st neglected to consider a 750,000-ohm resistor for shunt-feeding the plate of the 6K7 tube. His statements would apply if we had neglected to put in a 750,000-ohm resistor in parallel with the plate impedance of the 6K7 tube.

However, due to the fact that the plate of the 6K7 is being supplied with a shunt resistance of 750,000 ohms, the plate voltage may fall considerably below 75 volts.

As this resistor is in parallel with the plate impedance, the distortion is eliminated, as you will see by noting the complete circuit. If this 750,000-ohm resistor were omitted, there would be distortion as high as 20 per cent. However, with the circuit as used, the distortion introduced by this tube is a fraction of 1 per cent. This allows the impedance to change from 10,000 or 12,000 ohms to 1 megohm, giving a 12 db. differential for expansion.

H. V. NIELSEN,
Chief Engineer, Radio Division,
The Sparks-Withington Company.
Jackson, Mich., U.S.A.

7-Metre Reception

THERE are certain localities which are almost "hopeless" for the reception of the sound portion of the television broadcasts because of ignition interference. I have found, personally, that the use of an ordinary aperiodic aerial is sometimes superior to the more usual dipole; far more amplification is, of course, necessary, but the resulting signal-noise ratio seems to be improved. I can think of a reason for this, but it would be interesting to know your readers' practical experiences in comparing the two methods; actual confirmation is of more value than any theoretical consideration.

Ware. GERALD SAYERS.

Beat Oscillators

THE simplified beat oscillator described by Mr. C. P. Edwards in your issue of January 22nd is very neat, and for many purposes will, I am sure, do admirable work. But he makes no reference to purity of wave-form.

He attributes the complication and expense of the high-class commercial instrument mainly to stability of frequency and flat response; but in some cases, at any rate, by far the greatest difficulty is purity.

It must be realised that there are two essentials in securing this. First of all, at least one of the two RF beating currents must itself be pure; and this requires precautions which he has not taken. It is obvious that if *one* wave is pure, its beats with harmonics of the other produce RF components which can be removed; but if, for example, both have second harmonic, the beat will contain the second harmonic of its own frequency, and will therefore be impure.

Second, either the "mixer" must be square law, *not* linear, or one of the two beating currents must be very much greater than the other. This is why in most cases an anode bend rectifier is used to mix. The triode-hexode is a true modulator, and is approximately linear. If the effects of the two inputs on the electron stream are in the ratio 10 to 1, there will still be 2½ per cent. second harmonic in the beat; if 5 to 1, 5 per cent.

For many cases, of course, purity of wave-form is not important; but it should, I think, be realised that where it *is* needed an instrument of the type described must be regarded with suspicion.

P. K. TURNER, M.I.E.E.,
Isleworth. Hartley Turner Radio, Ltd.

External Speakers

MAY I call your attention to the inadequacy of the external-speaker terminals fitted to most modern receivers?

I quite realise (*vide* Free Grid) that they are apparently fitted as an afterthought, and, presumably, for a sales point rather than use; but I think that the cost of making them useful accessories would be so small as not to be noticed.

To begin with, most receivers use a speaker with a speech coil having one or two ohms impedance, and the external speakers are fitted across the output transformer secondary.

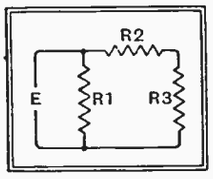
Assume a two ohms output, and calculate the performance of an extension speaker.

I take a concrete example.

I sent my sister a speaker to the specification in the instructions supplied with her receiver, and I know that it was going "good."

I soon had a letter to ask what was wrong, but as she mentioned seventeen extra yards of flex were required to run the extension I was unable to do anything but commiserate with her. Her remarks were that she had to be deafened by the set if the extension were to be heard.

The impedance network, reduced for simplicity to a resistance network, is shown in the figure.



E = speech currents.
R_1 = internal speaker.
R_2 = extension wiring.
R_3 = extension speaker.

Now, R1 is in parallel with R2 and R3 in series.

If R1 be two ohms, and R3 two ohms, and we assume twenty yards of twin flex (R3 becomes 1.9 ohms), the power in the two speakers may be calculated as 1 : 0.263, or 5.8 db down in the extension speaker.

If the load be connected across the primary of the output transformer the capacity of the wiring may have an appreciable effect on the high-frequency response, while isolating condensers will be necessary in both leads. I think, however, that a five-hundred ohms winding on the output transformer would not appreciably increase the cost and, at the same time, would be the most useful loading for extension use.

Nor would it be prohibitive to arrange a suitable transformer for the speaker end.

I would estimate the extra cost on the set at 1s. 6d. and on the speaker the same. Is three shillings too much to pay for efficiency in the extension speaker?

Inverness. H. MOORE.

Foreign Listening

UNLESS one is a good linguist, or one of those people that makes a close study of foreign programmes, it is purely a matter of chance "tuning" that a musical performance radiated from abroad is sustained long enough to be really appreciated.

In practice, a musical "treat" is often "tuned-in" and after a few moments that particular composition ends, followed by a considerable amount of unintelligible talk and uncertain intervals. At this the listener, with mixed feelings, usually proceeds to "tune-in" other uncertainties.

As these conditions are common to the majority of listeners, whether situated in this country or abroad, it appears that a partial solution may be found by the application of a dozen or so carefully chosen words which can be expressed internationally. The broadcast announcers' task would then be to express in a simple international code what is to come, before proceeding with a detailed description of this in their own language, at the end of a portion or the whole of a programme. To be of assistance the words would have to express kind of programme, time of commencement and duration.

Naturally, for the scheme to be successful, it would have to be applied internationally by such a body that is responsible for determining the wavelengths of broadcast stations.

Ipswich. A. ADCOCK.

Flutter

I HAVE occasionally noticed references in the technical Press to a phenomenon encountered in receivers employing amplified AVC—namely, a fluttering sound obtained upon tuning in a powerful carrier wave. Never having seen any reasons put forward for this effect, readers of your magazine may be interested in the conclusion drawn by myself after experimenting with a view to its elimination.

I soon found that the effect was not due to the decoupling of the AVC amplifier, although increasing the said decoupling did, in fact, partly reduce the intensity of the effect.

I then noticed that medium-strength carriers could be started fluttering upon increasing the manual AF control; this gave me a clue to work upon, and enabled me to discover that it was due to voltages at very low frequency (about 5-10 c/s) developed across the main HT supply being transmitted to the "screening grids" of the controlled RF pentodes, the effect being to cause "cross-modulation" of a powerful carrier due to non-linearity of the "I_a—E_{g2}" characteristic of these valves at high values of grid bias voltages (which, incidentally, shows why ordinary simple AVC is not affected).

I am unable to encroach upon your space sufficiently to give a complete explanation of the effect, it being somewhat involved and entails the use of several diagrams, but,

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Letters to the Editor—

nevertheless, the possible "cures" of the effect may be summarised as under:—

(*a*) Slight reduction of the bass response of the AF amplifier, preferably by use of a transformer coupled stage.

(*b*) Increase of time constant of AVC circuit to prevent sudden changes of steady grid voltage on controlled valves, which involves the use of a very slow acting control, insufficiently fast to prevent "blasting" (the radio variety!).

(*c*) Reduction of time constant of AVC circuit, which has much the same effect as (*a*).

(*d*) Increase of capacity in the main HT circuit, which entails the use of capacities of the order of 50 to 75 mfd.

(*e*) Increase of decoupling in the screening grid circuits of the controlled valves, also involving the use of fairly high capacities (in this case about 10 mfd.).

(*f*) The use of push-pull AF, which is, perhaps, the best method of all.

In conclusion, I should like to say that, in my opinion, the success or failure of most receivers in this respect (i.e., satisfactory AAVC) is due to one or more of the above arrangements, although I do not claim that they are effective in every conceivable case.

Wimbledon. R. G. YOUNG.

VITAVOX HORN UNIT

IN the description of PA loud speakers in our issue of February 5th the Vitavox unit was incorrectly referred to on page 139 as a product of Truvoice Ltd. This high-grade PA unit is, however, manufactured by Vitavox Ltd., Ashford Works, Ashford Road, Cricklewood, N.W.2.

THE RADIO INDUSTRY

FOR the benefit of those who are taking all possible precautions to ensure satisfactory reception of Coronation broadcasts (and particularly for those who intend to relay the transmissions to large audiences) Belling-Lee are putting into effect a novel suppressor-hire scheme. A complete "suppression kit," including a ready wired "Eliminoise" anti-interference aerial, is offered on hire at 25s. for the first week and 2s. 6d. per week subsequently up to four weeks maximum. Details from the makers: address; Cambridge Arterial Road, Enfield, Middx.

"This Year of Radio" is the title of an attractive publication just issued by Alfred Imhof, Ltd., 112-116, New Oxford Street, London, W.C.1. The book deals at length with the various facilities and services offered by the house of Imhof in connection with both radio and television.

Under the self-explanatory title of "Measuring Instruments for all Communication Frequencies," a leaflet has recently been issued by Marconi-Ekco Instruments, Ltd., Electra House, Victoria Embankment, London, W.C.2.

Change of address: International Television Corporation, Ltd. (The Mihaly-Traub Television System) from 45, Conduit Street, London, W.1, to Maidstone House, 25-27, Berners Street, London, W.1. Telephone: Museum 2330.

The G.E.C. has opened a Television Enquiry Bureau at Magnet House, Kingsway, London, W.C.2.

Four New G.E.C. Sets

THE current range of G.E.C. receivers has recently been extended to include three new all-wave receivers (one a battery model) and a mains transportable.

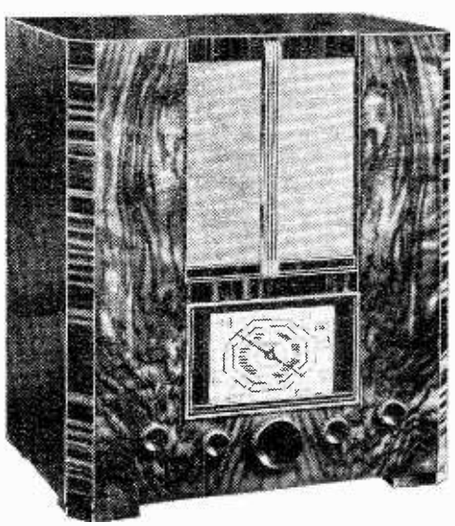
In the Fidelity All-Wave 8 at 25 guineas a power output of 6 watts is available for the 9in. moving-coil loud speaker. The short-wave band goes down to 13 metres, and there is an adjustable sensitivity control. A new dial has been designed with a subsidiary micro-tuning pointer.

Variable selectivity is provided in the All-Wave 6 receiver, which has four wavebands and a three-step muting and sensitivity control. The dial is similar to that of the All-Wave 8, and there is, in addition, a special neon-type tuning indicator. The power output is 3 watts, and the price 19 guineas.

Both the foregoing sets are available in alternative forms suitable for the Empire market with an additional short-wave range but without a long-wave band.

The Fidelity All-Wave Battery receiver has a signal frequency RF amplifier, heptode frequency-changer, two stages of IF, double-diode-triode second detector with AVC, and a QPP output stage. The wave-range is 13.6 to 550 metres in four bands, and the tuning dial is of the same type as that used in the mains receivers. Including valves, the price is 17 guineas and a vibrator unit for HT supply is available.

Designed for use without an external aerial or earth connection the AC Transportable 5 operates from AC mains and has



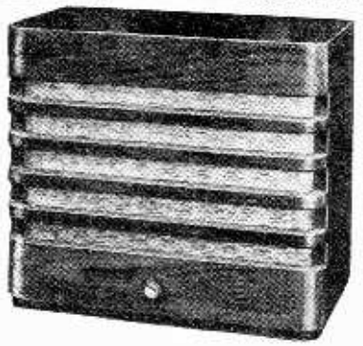
G.E.C. Fidelity All-wave 8 with 6-watt output stage.

a superheterodyne circuit with RF amplifier, triode-hexode frequency-changer, single IF amplifier, double-diode second detector and high-slope pentode output valve. The cabinet is mounted on a turntable and suitable lifting grips are provided at the sides. There are the usual medium- and long-wave ranges, and the price is 16 guineas.

Reverberation Control

THE new system of studio acoustics described in *The Wireless World* of February 12th was introduced at the Poste Parisien station on Tuesday, February 23rd. Listeners will no doubt be interested to observe the degree of realism which this system introduces.

Concerning The ROLA 'REX' UNIVERSAL EXTENSION SPEAKER



CABINET Responsibility

Let us expound the doctrine of Cabinet responsibility as applied to an Extension Speaker. It means that since a cabinet speaker is so often judged by its appeal to the eye the unit inside must be in every way worthy of the cabinet in which it is housed. With a speaker such as the Rola "Rex" the responsibility is great indeed, for the cabinet is a veritable triumph of the designer's art. Yet connoisseurs agree that the remarkable reproduction of the speaker is as delightful to the sense of hearing as the cabinet is to the sense of sight. They also say that 49/6 is a very moderate price for a speaker of such quality, especially since it can be matched exactly to any receiver.

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SPEAKER — 8" Diameter. Special Nickel Aluminium Cobalt Magnet. Ten alternative impedance settings.

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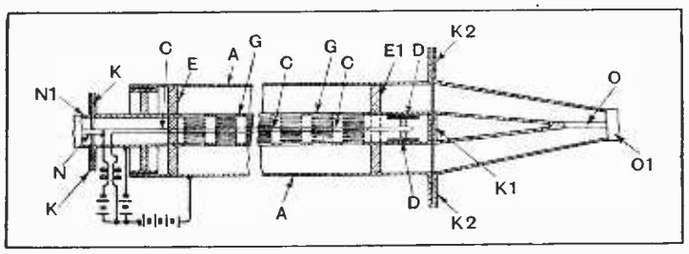
Recent Inventions

Brief descriptions of the more interesting radio devices and improvements issued as patents will be included in this section.

SHORT-WAVE AMPLIFIERS

RELATES to an amplifier designed to handle waves which are shorter in length than the electrodes of the valve. As shown, the amplifier comprises a hairpin cathode C surrounded by a negatively biased grid G and a cylindrical anode A, the evacuated space being completed by end-walls E, E1.



Design of valve intended for use at very high radio frequencies.

The input circuit consists of a coaxial transmission line N, N1, of which the inner conductor N is directly connected to the cathode, whilst the outer tube N1 is capacitively coupled to the grid of the amplifier through condenser plates K.

The output circuit is a similar coaxial transmission line O, O1, the two conductors of which are capacitively coupled at K1 and K2 to the grid and anode respectively. The conical end extensions, together with the disc D, ensure a matched impedance coupling between the valve and the load.

Standard Telephones and Cables, Ltd. (*assignees of R. K. Potter*). *Convention date* (*U.S.A.*), *January 22nd*, 1935. *No.* 456301.

oooo

PHOTO-ELECTRIC CATHODES

RELATES to flat photo-sensitive cathodes as used for converting an optical image into an "electric facsimile," prior to scanning in television. In order to obtain an undistorted image of the largest possible size the sensitive cathode is fitted with a cylindrical flange, pointing towards the usual accelerating-electrode in a cathode-ray tube. This ensures that the electron stream strikes the cathode at right-angles over its whole surface, i.e., at each point on which the stream impinges during the scanning process.

W. Heimann. Convention date (*Germany*) *May 20th*, 1935. *No.* 456316.

DEFLECTING THE ELECTRON STREAM

COMPARING the relative merits of electromagnetic and electrostatic deflection, as applied to a cathode-ray tube, the first method is open to the objection that the two magnetic fields are liable to interfere with each other and so produce distortion. On the other hand, when using the second method it is necessary to increase the distance between the "gun" part of the tube and the fluorescent screen, in order to provide sufficient room to accommodate two pairs of deflecting plates. As a compromise it is common practice to use a magnetic field for one direction of deflection, and a single pair of condenser plates for the other direction.

According to the invention, space is economised by locating at least one pair of condenser plates so that they extend partly into the bulb part of the tube, where they are at a comparatively short distance from the fluorescent screen. The plates are "flared" outwards towards the screen and are separated from it by a "ring" electrode, which serves to trap any electrons produced from the screen by secondary emission. The fact that they extend into the bulb part of the tube allows the deflecting plates to be more widely spaced apart than is possible in their usual position in the neck or stem of the tube.

Marconi's Wireless Telegraph Co., Ltd. (*assignees of V. K. Zworykin*). *Convention date* (*U.S.A.*). *April 28th*, 1934. *No.* 455927.

oooo

"ROLLING CUTS" IN TELEVISION

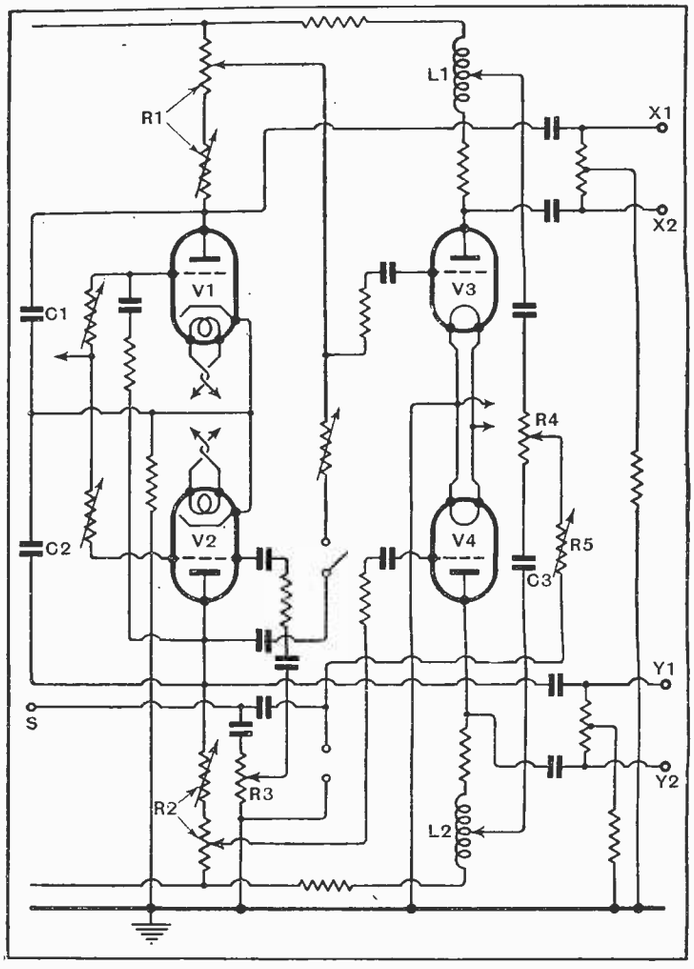
IT is sometimes desirable, when transmitting a television programme, to be able to change-over from one studio to another. The invention is concerned with ways and means for fading-out a given studio and replacing it by another, or, as it is termed, making "rolling cuts." The scanning devices at each of the studios in question are connected to a "mixer" through a control circuit, which is also coupled to the oscillation-generator for the synchronising impulses. When changing-over, one scanner is made operative and other inoperative by altering the grid bias on the corresponding amplifier through the control circuit. The two amplifiers are so interlocked that only one scanning device can be effective at any one time.

C. F. Chapter and Baird Television, Ltd. Application date May 11th, 1935. *No.* 456582.

oooo

TIME-BASES FOR TELEVISION

THE two pairs of deflecting plates X1, X2 and Y1, Y2 of a cathode-ray receiver are energised in push-pull, and means are provided for extinguishing the cathode-ray beam during its "fly-back" motion.



Time-base circuit with provision for intermittently extinguishing the cathode-ray beam.

Line and frame scanning voltages are derived from the condensers C1, C2, which are charged up through resistances R1, R2 and discharged by the valves V1, V2, in response to synchronising impulses applied to a resistance R3. The resulting oscillations are passed through phase-reversing valves V3, V4, so that the two deflecting plates X1, X2 are impulsed in phase opposition through the valves V1, V3, whilst the second pair of deflecting plates Y1, Y2 are similarly fed in push-pull from the valves V2, V4. Inductances L1, L2 in the output circuits of the second pair of valves meanwhile develop voltages which are fed back through resistances R4, R5 to the shield S of the cathode-ray tube, in order to suppress the cathode-ray stream during its rapid flyback stroke.

E. Reader and L. Glass. Application date, June 25th, 1935. *No.* 456288.

oooo

SYNCHRONISING SYSTEMS

RELATES to the method of transmitting television in which synchronising impulses are inserted in the interval between successive "trains" of picture signals. In such a system it is known to be desirable to reduce the carrier-wave component substantially to zero amplitude, at times when the synchronising impulses are at their peak. This result is secured, according to the invention, by passing the synchronising impulses through a resistance which develops a biasing voltage sufficient to paralyse one of the valves in the modulating circuit, thereby suppressing the carrier wave.

A. D. Blumlein and E. A. Nind. Application date, April 3rd, 1935. *No.* 456135.

The British abstracts published here are prepared, with the permission of the Controller of H.M. Stationery Office, from Specifications obtainable at the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1/- each. A selection of patents issued in U.S.A. is also included.

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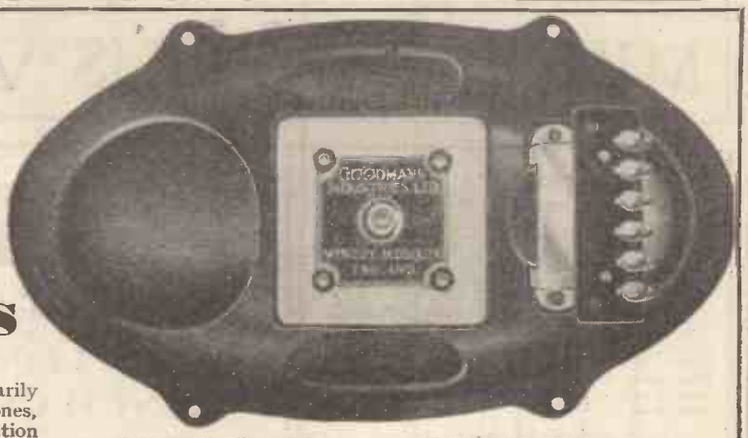
Advantages of ELLIPTICAL Cone Loudspeakers



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The Cone is a true ellipse and is exponentially shaped. On the minor axis the cone has a very sharp angle, thus giving increased efficiency in the upper frequencies, whereas on the major axis the cone is projected to a very shallow angle. This shallow angle gives increased loading at the lower frequencies, with consequent increase in output.

The overall response is extremely level and is well maintained at both ends of the frequency scale, whilst the sensitivity is increased without the introduction of undesirable resonances.

This Loudspeaker has the additional advantage that it can be mounted in a comparatively small space in the Cabinet, either above or below the Set chassis, thus facilitating a reduction in physical dimensions of the complete Receiver.

DEMONSTRATIONS of this new **Elliptical Cone Loudspeaker** given at the weekly Demonstrations held every Thursday Evening at the Wembley Works between 6 p.m. & 7 p.m. (5 mins. from Wembley L.M.S. & Bakerloo Stn., & Buses & Trams)

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By A. L. M. SOWERBY, M.Sc.

An Elementary Text Book on Wireless Receivers

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Eleven of the eighteen chapters of the book deal with the discussion of receivers in which the whole process of design is reviewed stage by stage to the finished article.

Special attention is paid to the important subject of tuned circuits and band-pass filters, on the correct design of which the performance of every type of set ultimately depends. Moreover the process of detection, so often imperfectly understood, is clearly explained.

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A.

A.

DEGALLIER'S, Ltd., the best firm for reliable fully guaranteed ultra short-wave radio, have on view in London without exception the largest selection of all-wave receivers, at very low prices. For instance, an 8-valve superhet., with 3 bands going down to 16 metres, at £9. An 8-valve superhet., 4 bands going down to 11 metres, with push-pull output 8 watts undistorted, is only 13 guineas. Any known American valve for receivers 1925-1937, glass, glass counterparts, metal, and M.C. at 6/6 each, all firsts. They have range like this right up to a 24-valve Challenger twin-chassis, valves and two Auditorium speakers, 5-bands 5-2,050 metres, 60 watts undistorted at £50. They guarantee that every S.W. receiver will get stations on the low bands including the Americas, etc. Why not call and handle these receivers at your leisure? Demonstrations daily from 3.30 onwards on American transmissions. No obligation to purchase. Or send large S.A.E. for beautifully illustrated catalogues with actual photographs. Also in stock, Ferguson, Belmont, etc.

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LATEST 6-valve Car Radio, A.V.C., remote control, no suppressors required.

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HENRY FORD RADIO, Ltd.,

ELECTRONIC House, 22, Howland St., Tottenham Court Rd., W.1. Museum 5675. [0511

DISTANCE LENDS ENCHANTMENT

. . . to the view, perhaps; but not to the broadcast programme—not in the author's sense, anyway. For the "enchantment" in this case is an evil spell; a plague of interference or alternatively a blurring due to loss of the upper frequencies.

So for any given set of conditions we must adopt a compromise: lose just enough "top" to cut out the interference, while retaining as much as possible of the tone-colour. It is here that you score with the

HARTLEY-TURNER

M.A. RECEIVER

Owing to the "demodulating" effect achieved by using single-peak circuits plus tone-correction, you can always get ***a much greater band-width for equal interference.***

The receiver is really versatile. Whenever conditions are reasonably good, you get HARTLEY-TURNER QUALITY. When they are bad you still get much better results than are obtained with the usual type of circuit.

In production now: but most of the first batch is already sold. Prices:

M.A.7 — 7 watt output = = £32.10.0

M.A.12—12 watt output = = £35. 0.0

NEW NOTES IN RADIO

Two booklets (116pp. in all) giving the ideas behind the design of quality sets and speakers. Vol.I, The Speaker; Vol.II, The Set. Price 6d. each volume. We have just produced a 16pp. supplement to Vol.II, dealing with our S.A. and M.A. receivers. Included gratis with Vol.II.

For our many clients who have Vol.II, the Supplement is available separately at 2d. (3d. post free).

HARTLEY TURNER RADIO LTD.,
THORNBURY ROAD,
ISLEWORTH, MIDDLESEX.
Telephone: HOUnslow 4488

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For the convenience of private advertisers, letters may be addressed to numbers at "The Wireless World" Office. When this is desired, the sum of 6d. to defray the cost of registration and to cover postage on replies must be added to the advertisement charge, which must include the words Box 000, c/o "The Wireless World." All replies should be addressed to the Box number shown in the advertisement, c/o "The Wireless World," Dorset House, Stamford Street, London, S.E.1. *Readers who reply to Box No. advertisements are warned against sending remittance through the post except in registered envelopes: in all such cases the use of the Deposit System is recommended, and the envelope should be clearly marked "Deposit Department."*

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NEW RECEIVERS AND AMPLIFIERS

A

AIR KING.

THE Royalty of Radio.

ALL Models Feature Beam Tuning, Magic Eye indicator, gramo. pick-up connections, and special output valves.

ALL Sets Fully Guaranteed; H.P. terms available from 3/- per week; our technical department is at your service.

WHOLESALE and Trade Enquiries Invited; generous terms.

ARCTURUS Valves for Improved Radio Reception on All Types of Receivers.

WRITE for Lists of These Famous Valves; prices from 4/9 each.

AIR KING RADIO, 115, Shaftesbury Av., Cambridge Circus, W.C.2 (1st floor above Barclay's Bank). 'Phone: Temple Bar 4875 (all lines). All receivers assembled in England. [3406

ALERT RADIO Co.

COMMUNICATION Receivers, all-wave chassis, complete receivers of all types, American valves, spares and service; we also have a few reconditioned receivers.—21, East Rd., N.1. Clerkenwell 4871. [3787

HARMAUR RADIO.

AMERICAN-BOSCH "CentrOmatic" All-wave Sets.

FREED-EISEMANN Receivers as Bought by the B.B.C.

DE WALD A.C./D.C. All-wave and Car Radios.

RAYTHEON Valves; trade enquiries.

THE HARMAUR RADIO Co., Ltd., 8, Clifford St., New Bond St., London, W.1. [0499

THE COULPHONE RADIO Mfg. Co., Ltd., of Hutton, Preston, Lancs.

MANUFACTURE the Following 8-valve 8 watt 4 waveband Radiogram Chassis with Phase Reversed Push-pull Output, price £9; with Rola G12 or Magnavox "33," £11/5; carriage paid; 12 months' guarantee, including valves.—'Phone: Longton 196. [3890

CANNOT Repeat.—7-valve all-wave superhets., Magic Eye, £9; others from £5/10; 5-valve portable Midgets, leatherette, £3/5.—A. Luke, 165, Rushey Green, Catford, S.E.6. Hither Green 2864. [3886

COMMUNICATION Receivers, Hammarlund, National, Hallicrafters, R.M.E.69, Tobe-Deutschmann; transmitters, Collins 45A, Peerless DX20, or built to order; American valves, microphones, Eddystone components.—A.C.S., Ltd., 52-4, Widmore Rd., Bromley. 'Phone: Ravensbourne 0156. [0550

"Radio Data Charts," A Series of Abacs Post free 4/10

NEW RECEIVERS AND AMPLIFIERS

A

N

GLO AMERICAN RADIO Offer the Finest Range of Chassis and Receivers at London's Lowest Prices.

£12/19/6.—Crossley 9-valve 5-waveband chassis, 10 watts output, Neon tuning indicator, gramo., 13-580 metres continuous and 780-2,100 metres, the finest radio to-day, 12in. Magnavox speaker, 20/6, A.C. 80-270v.

£9/19/6.—9-valve all-wave chassis, 16-2,000 metres, visual tuning, magnificent performance; speaker, 15/6; complete receiver, £11/10/6.

£8/19/6.—8-valve all-wave chassis, 16-2,100 metres, visual cathode tuning, 7½in. super airplane multi-indication dial, 4 watts output, A.V.C. tone control, A.C. operation, 110-240v.; matched speaker, 12/6; complete receiver, £10/7/6.

£7/19/6.—8-valve all-wave chassis, 16-2,100 metres, new De Luxe 5½in. airplane multi-indication dial A.V.C., tone control, calibrated all bands, 110-240v. A.C./D.C.; matched speaker, 12/6; complete receiver. £9/6/6.

£5/19/6.—Car Radio 5-valve superhet, highly efficient, A.V.C., tone control, illuminated dial, magnificent performance, complete with suppressors and sundries and complete operating and fixing instructions; demonstrations under London traffic conditions daily.

67/6.—All-wave battery chassis, S.G. H.F. Pen-det.-Pentode, 16-2,000 metres, 3 bands, latest all-wave slow motion dial calibarted in metres, P.U. and extra speaker sockets, an excellent home receiver; supplied direct from prominent British manufacturer, 8in. moving coil speaker, 10/6; complete receiver. £4/10/6.

50/-.—Exceptional bargain; Multi-band (7-2,000 metres) Communications outfit, battery, valves, 8in. speaker, metal cahinet, 7in. dial, with S.W. station names, band-spread together with 8in. world rotating globe on stand.

49/6.—4v. 180-2,100 metres chassis, powerful all-Pentode circuit, good gramo. reproduction, A.C./D.C. 100-240v., an unprecedented offer; speaker, 10/6; complete receiver, £3/8/6.

4/6.—Valves, all types American and British (Continental) A.C. and A.C./D.C.; 6/6, 8in. dynamic speakers; 2/6, headphones; 3/-, line resistances, any value; £5/19/6, Garrard auto record changer, motor, pick-up, complete, plays 10 records.

ORDER with Every Confidence; any goods unsuitable will be exchanged for any others selected; we have the largest range and lowest prices in the country.

TERMS.—Cash or c.o.d.; carriage on all chassis, 2/-.

IF Near London, call or 'phone for demonstration at time to suit.

ANGLO AMERICAN RADIO (AND MOTORS), Ltd. (Dept. W.6), Albion House, New Oxford St., London, W.C.1. (Telephone: Temple Bar 3231.) [3847

McCARTHY RADIO Special Offer.

McCARTHY RADIO have for Disposal a Number of Chassis at Attractive Prices; these are demonstration models, and therefore slightly soiled, though otherwise in new condition; fitted brand new B.V.A. valves throughout.

OFFERED as Complete Receivers, in brand new cabinets, with moving coil speakers, the following types:—

£6!! (Complete in Cabinet, with speaker, as above).—6-valve Band-Pass Superheterodyne, with 3-watt pentode output; illuminated dial, principal station names; medium and long wave-bands, D.A.V.C., volume control, tone control (both operative on gram.).

£6/10!! (Complete in Cabinet, with speaker, as above).—6-valve all-wave superheterodyne covering 3 wavebands (17-2,000 metres); illuminated "Airplane" dial, D.A.V.C., "Squelch" circuit, with muting control; provision on switch connects pick-up terminals; 3-watt pentode output.

£7!! (Complete in Cabinet, with speaker, as above).—6-valve all-wave superheterodyne, specification as above, but with tone control and 6-watt push-pull output.

£8/10!! (Complete in Cabinet, with speaker, as above).—8-valve all-wave receiver, with 6-watt triode push-pull output. R/F stage, 4 wave-bands (16.5-2,000 metres), illuminated "Airplane" dial, tone control, volume control (both operative on gram.), etc., etc.

LIMITED Quantity Only of these Bargain Receivers Available.

McCARTHY RADIO, Ltd., 44a, Westbourne Grove, London, W.2. Telephone: Bayswater 3201. [3873

£26. bargain.—Hammarlund Comet Pro, with crystal, complete with all accessories.

£13/13.—11-valve all-wave receiver, 4 bands, 12-2,050 metres, selectivity illuminated dial, vernier tuning, incorporating every newest feature, selective, sensitive, amazing quality, 6 watts, undistorted output.

£13/13.—8-valve A.C., similar specification to above.

£9.—6-valve A.C./D.C. all-wave, 16-2,000 metres, A.V.C., illuminated station name dial, amazing performance, beautiful walnut cabinet.

£9.—Skybuddy by Hallicrafter, 5-tube A.C. superhet., band spread tuning, A.V.C., on or off B.F.O., 'phone jack, built-in speaker, pitch control, all-metal cabinet, Raytheon valves.

OUR Guarantee, "satisfaction or money refunded."

RADIOGRAPHIC, Ltd., 66, Osborne St., Glasgow, C.1. [3900

No. 27.

Notes on the Suppression of Electrical Interference with Wireless Reception

Having just returned from a week-end at a big farmhouse in Wiltshire, the writer has had an interesting experience of interference under truly rural conditions.

The farm, along with eight other big local houses, buy their power from a mill, 250 v. D.C The commutation ripple was not really troublesome but the interference from other sources was very severe. In particular, switch clicks were frightful; incubator thermostats came in with an extraordinary splash.

The receiver is an old straight four, with a reasonably decent outside aerial. They are in the market for a more modern receiver, but no one has been able to give a worth-while demonstration on these mains. No one has tried suppressors or anti-interference aerials. They were delighted when it was suggested that they should go ahead and choose their receiver and specify a Belling-Lee All-wave Set Lead Suppressor,† type 300, and, if necessary, an "Eliminoise"* aerial. Under such conditions they cannot go wrong, because the aerial can be run as and where they like, well clear of buildings and outside any possible field of interference.

There must be thousands of country families in the same boat; yet generally speaking the dealer is not alive to the possibility that these people actually want new receivers and can well afford to pay for any suppression appliances required.

In order to meet the requirements of those interested in loudspeaker (public address) schemes for the Coronation, we are prepared to hire a complete suppression equipment comprising an anti-interference aerial (75ft. span, "Eliminoise" transformers, and 150ft. lead-in and all insulators already wired up ready to be hoisted), and one Set Lead Suppressor, type 300. The list price of the equipment is £5 14s., the hire price 25s. nett for the first week, and 2s. 6d per subsequent week up to four weeks maximum. Price includes packing and carriage one way.

This scheme has been put into force as a result of numerous enquiries, and those interested in such a scheme are invited to get in touch with us without delay. Orders will be dealt with in trict rotation.

† Set Lead Suppressor, type 300, 10 to 2,000 metres, 1-amp. 21s.

* "Eliminoise" (Trade Mark) all-wave anti-interference aerial, 10 to 2,000 metres, 35s. Cable extra, 10d. per yard.

Send for book "Interference Suppression," post free 1s. 2d. or for free copy of "The Eliminoise System" and other relative literature.

BELLING-LEE
SUPPRESSION SERVICE

Belling & Lee Ltd.
Cambridge Arterial Road,
Enfield, Middx.
Telephone: Enfield 3322.

NEW RECEIVERS AND AMPLIFIERS

ARMSTRONG COMPANY Manufacture 8 Radio Receivers in Chassis Form, briefly described hereunder.

ARMSTRONG 6-valve All-wave Superheterodyne Radiogram Chassis, for A.C. mains, complete with Rola speaker; £7/10.

ARMSTRONG 8-valve 4 Wave-band Radiogram Chassis, with phase reversed push-pull output; £9/17/6.

ARMSTRONG 6-valve 4 Wave-band Radiogram Chassis, with large triode output; £8/17/6.

ARMSTRONG 8-valve 4 Wave-band Radiogram Chassis, with radio-frequency stage and push-pull output; £11/11.

ARMSTRONG 7-valve 4 Wave-band Radiogram Chassis, with radio-frequency stage and single triode output; £10/10.

ARMSTRONG 8-valve 2 Wave-band Radiogram Chassis, with 8 watt push-pull output; £8/10.

ARMSTRONG 6-valve 2 Wave-band Radiogram Chassis, with single large triode output; £7/10.

ARMSTRONG Chassis Carry 12 Months' Guarantee.

ARMSTRONG Chassis are Sent 7 Days' Trial, carriage, packing and crate free.

ARMSTRONG MANUFACTURING Co., 100, King's Rd., Camden Town, N.W.1. [3460

"WIRELESS WORLD" Quality Amplifiers, modified 5-12 watt, with many refinements, £10/10; Standard 6 watt, £8; Pretune 6 watt, £7; feeders, 30/-; all ready switch on; enquiries welcomed.—Grant, 3, Emyln's St., Stamford. [3881

TRANS-ATLANTIC RADIO for Better All-Wave Value Than Obtainable Elsewhere; also long and medium wave compacts from 59/6; satisfaction guaranteed; Philco agents; lists sent; sets repaired by experts.—Trans-Atlantic Radio Co., 15, Percy St., W.1. Museum 3096. [3891

PILOT, Ferguson, Belmont, Pegasus, and Air King all-wavers lead the field; our deliveries are prompt in original cartons, with full guarantees; your trade card will bring our wholesale catalogue from the authorised distributors.—Leonard Heys, 36, Henry St.; Blackpool. [0530

RECEIVERS AND AMPLIFIERS
CLEARANCE, SURPLUS, ETC.

CLEARANCE List (Trade Only).—Write Leonard Heys, 36, Henry St., Blackpool. [0527

FARREX Short Wave Units Get Those American Stations; listed at £3/3, our price 30/-; brand new; carriage paid.

HENRY'S, 72, Wellington Av., London, N.15. [3909

W.W. Fixed Tune Receiver, including variable tuning, and quality amplifier, original specification, matched valves, new, £12; amplifier alone, £7.—119, West Side Clapham Common S.W.4. [3675

PUBLIC ADDRESS EQUIPMENT

SPECIAL Offer!!!

8½ Guineas Assembled: Vortexion 20 watt 4-stage P.A. amplifier, in steel case, 8in.×10in.×9in. high, with carrying handle, input with controls for microphone and pick-up and tone control, output for 7½ and 15 ohm speakers, weight 25lb.; only 8½ guineas, with valves.

4 Input Model, with mixers; £10.

HEAVY Duty Model, as fitted to cinemas and dance halls; £15.

CALL and Hear the Rumble of an Organ as Never Before on our Wide Frequency Range Models, the best yet.

VORTEXION, Ltd., 182, The Broadway, Wimbledon, S.W.19. See our displayed advertisement on page 6. [3904

PARTRIDGE P.A. Manual, free to trade. See "Partridge Transformers" under "New Mains Equipment." [3487

USED SETS FOR SALE AND WANTED
EDDYSTONE

SHORT-WAVE Eddystone Kilodyne Battery Four, 1936 model, with valves and coils, excellent condition, cost £9; selling for best offer.—Roberts, 25, Brighton St., Penkhull, Stoke-on-Trent. [3869

W.W. MONODIAL

1936 Monodial and Quality Amplifier, Magnavox "66," tweeter, etc.; particulars stamp; £16.—Hassell, Derwent Lodge, Uckfield. [3876

W.W. QUALITY AMPLIFIER

BRAND New, used test only, modified 5-12 watt quality amplifier with 7 valves, £9/9; feeder 25/-.—Grant, 3, Emlyn's St., Stamford. [3882

MISCELLANEOUS

SOUND Sales 2.H.F. Feeder Unit, perfect condition; £6 or offer.—P. Rawson, 62, Nunsfield Rd., Buxton, Derbyshire. [3854

"REVOLUTIONARY."—R.S.G.B. Bulletin; new detection theory, system, circuits, book, post free 1/1.—D'Arcy Ford, Gandy St., Exeter. [3859

NEW MAINS EQUIPMENT

ALL POWER TRANSFORMERS Ltd.—Transformers and chokes embodying all the best in design; no better value at any price; Radiolympia models; tapped and screened primaries, filaments, centre tapped.

250-0-250v. 60 m.a., 4v. 1-2a., 4v. 2-4a., 12/6, post 7d.; extra filament, 4v. 1a., 12/6.

350-0-350v. 60 m.a., 4v. 2-3a., 4v. 2-4a., 15/-, post 8d.; extra filament, 4v. 1a., 16/-.

350-0-350v. 120 m.a., 4v. 2-3a., 4v. 4-6a., 4v. 1-2a., 19/-, post 1/-; extra filament, 20/-.

500-0-500v. 140 m.a., 4v. 2-4a., 4v. 4-6a., 4v. 2a., 4v. 2a., 29/6, post 1/-.

L.T. Charger, charging rate 1a., 2, 6, or 12-volt, employing metal rectifier L.T.5, 37/6, post 1/-.

WRITE for List; special quotations by return.

ALL POWER TRANSFORMERS, Ltd., 8a, Gladstone Rd., Wimbledon, S.W.19. Tel.: Liberty 3303. [3383

PARAMOUNT Mains Transformers.

PARAMOUNT in Quality, lowest in price; example: 250v. 60 m.a., 4v. 1a., 4v. 4a., open type 9/-, shrouded 11/-, post 9d.; 350v. 75 m.a., 4v. 2.5a., 4v. 4a., open type 12/-, shrouded 14/-, post 9d.

WRITE for List, "Paramount Mains Transformers."—R. H. Salter, 66, Hartfield Rd., Wimbledon, S.W.19. 'Phone: Liberty 3226. [2303

PARTRIDGE Transformers, as supplied to B.B.C., Marconi's, G.E.C., Mullards, I.C.I., Tungsram, etc.

SPECIALS Despatched Within 48 Hours; all standard types from stock.

SPECIAL Quotations to Manufacturers for Lots of 6 Upwards; hand wound, individually tested, immediate delivery, rock bottom prices.

TELEVISION Transformers Insulated to 10,000v. A.C., expert knowledge of transmitting requirements (mains and modulation).

HIGH Fidelity (20 to 15,000 Cycles) Intervalve and Output Transformers a Speciality.

PARTRIDGE P.A. Manual Free to Trade Only; contents includes constructional amplifiers, notes on microphone pre-amplifiers, lines, mixing, impedance matching, speakers, etc.

PARTRIDGE, N., B.Sc., A.M.I.E.E., King's Buildings, Dean Stanley St., London, S.W.1. 'Phone: Vic. 5035. [3717

VORTEXION Transformers.—See our displayed advertisement on page 6. Also last week this column. [3903

TANTALUM for A.C. Chargers, H.T. and L.T.—Blackwell's Metallurgical Works, Ltd., Garston, Liverpool. [2729

MAINS EQUIPMENT

SECOND-HAND, CLEARANCE, SURPLUS, ETC.

D.C. Eliminators, Ekco, Atlas, Regentone, Lissen, 15-25 m.a., listed at 29/6, in guaranteed working order; 12/6 each.

HENRY'S, 72, Wellington Av., London, N.15. [3910

CABINETS

RADIOGRAM Cabinets, new designs, 30/- to £5/10; inspection invited or photos for selection sent on request.

TABLE Radio Cabinets, undrilled, 6/6 upwards.

SPEAKER Cabinets, 4/6 upwards.

MANUFACTURERS' Clearance.

K.B. De Luxe Walnut Cabinets, undrilled, chromium plated edges and speaker grille, 25in. wide, 14½in. high, 10½in. deep, 18/6; Console model, 42in. high, 21½in. wide, 11½in. deep, 39/6.

HALCYON Radiogram Cabinets (Reconditioned), 33×23×19, 35/-.

H. L. SMITH and Co., Ltd., 287-9, Edgware Rd., London, W.2. Tel.: Pad. 5891. [0485

DYNAMOS, MOTORS, ETC.

ALL Types of Rotary Converters in Stock, new and second-hand.

WARD, 46, Farringdon St., London, E.C.4. Telephone: Holborn 9703. [0518

D.C. to A.C. Rotary Converter (Crypto), 200/40 input, A.C. output 230 volt 500 amps.: £5.

ROTARY Converter, 12 volt L.T. input, 200 volt H.T. output at 40 milliamps; 50/-.

NEW Electro Dynamic Rotary Converter, 110 D.C. input, 230 A.C. output, 200 watts; £7/10.

THE UNIVERSAL RADIO Co., 221, City Rd., London, E.C.1. [3878

A.C. 1/10h.p. Induction Motors, 2,750 revs., self-starting, all voltages; 35/-.—Easco, 18, Brixton Rd., S.W.9. [0455

ELECTRO-DYNAMIC Converter, noise suppressor, soundproof box, 110 D.C./230 A.C., 120 watts, cost 15 guineas January 1936, perfect order; 5 guineas.—Machells, 45, Great Western Rd., Glasgow, C.4. Douglas 6140. [3865

G.E.C. Rotary Converter, 200-250 D.C. to 200-250 A.C., 200 watts, complete with smoothing equipment, in steel silence cabinet, worth £30; accept £6/10.—Johnson Engineering, 86, Great Portland St., London, W.1. Museum 7852. [3887

METERS

ELECTRADIX BARGAINS IN METERS

can always be relied on. There is a snip just in.

Genuine Weston model 354. Central zero 1 to 15 amps., pol. mag. dead beat. Flush, panel 2½in. dial, nickel or black. Sale price 10/6. Mounted in solid mahog., 3in. sq., 12/-. Hoyt CZ mov. coil miliammeters, 25-0-25 m/a., 10/-. Weston, 0 to 30 m/a mov. coil milliammeters, 17/6.

TESTERS. No. 108, with moving-coil meter and graded Rheo, 37/6. Silvertown astatic horizontal Galvos, jewel pivots, 7/-. Ammeters, all ranges to 20 amps., 7/-. Recording Graph. 12-hr. Chart Ammeters, £5 10s.

TESTING SETS. Elliott, etc., E. 108, 4 ranges amps. and volts, 37/6; 6 and 110 volts, 5/9. Cell Testers, pocket, 15/-; with spikes, 30/-. Bridges, 10,000-ohm 4-dial Wheatstone, with Galvo, £10. G.P.O. type, £7 10s. Mirror Galvos Reflecting Beam, by Paul Gambrell, Sullivan and Tinsley, £3 to £10. Standard Res. Boxes and Univer. Shunts, from 15/-. Electrostatic Voltmeters to 2,000 volts, £2. Record Circuit, 25/-. Weston Moving Coil Panel Meters, 30 m/a., 17/6. First grade Moving Coil Meter Movements for 5/-. In portable wood case, 7/6. A £15 AC/DC Sullivan Radio Tester, model S, new, £5 17s. 6d. Radiolab., £2 10s.

4in. to 8in. dia. SWITCHBOARD METERS. We carry large stocks of Meters, all ranges. Charging Pole Testers, 2/6. 0-20 volts, 5/9. 0-50 volts, 5/9. 0-100 volts, 5/9. 0-200 volts, 6/-, all A.C. or D.C. Meter repairs.

HIGH FREQUENCY METERS. 2½in. dia. to 8in. **HOT WIRE** to 1½ amp. and 2 amps. and 20 amps. Mov. Coil Thermo, 1½ amps., 6 amps., and 12 amps. Cheap.

PRECISION METERS

MICRO-AMMETERS for Valve Voltmeters, etc., 0 to 50 microamps full scale, 50 mV. moving coil, flush panel, 2½in. dial. Reads direct signal strength on crystal, 1,000 ohms., 40/-. See "Wireless World" report, page 158, August 14th issue.

The DIX-MIPANTA. This is a wonderfully versatile pocket moving-iron multi-range meter for service on A.C. jobs. No projecting terminals. THREE ranges of volts: 0-7.5, 0-150, 0-300. Used for MILLIAMPS reads: 0-12½ mA. and 75 mA. In black bakelite case, 2½in. by 2½in., 19/6. **DIX-ONEMETER 50 Range Test Set.**—Will measure 0-100 millivolts 25 microamps. to 20 amps. **Dix-onemeters are now only 55/-.** This is a remarkably small price for a meter worth £10 in comparison with others. Latest model. Mirror Double Scale. Moulded Base. The finest Precision Multi-Measuring instrument is the DIX-ONEMETER. A de Luxe Meter in Case, only 55/-. Multipliers, 6/6 each. **Radio Outfit Test Set,** complete in Case with five Multipliers, £4 10s.

OSCILLOGRAPH. Paul-Irwin 2-element thermo, motor driven prism, with shunts, condensers and plate camera. Overall mahog. base, 4ft. 6in., cost £85. Sale, £9 10s. Suit College or Lab.

S/W WAVEMETERS, 4 to 85 metres, £2 10s. McLachlan Het. W.M. 20 to 5,000 metres, £4. Gambrell, Type D, £2. Ditto, 75 to 12,000 metres, £2 15s. Sullivan Screened Het. to 16,000 metres, 65/-.

FREQUENCY TEST RECORDS, 10in. Cut to constant amplitude. Harmonic content under 3%, 2/6 each.

MEGGERS AND OHM-METERS, 1,000 ohms. to 20 megs., from £5 10s.

MAGNETIC SWITCHES. No switchboard complete without one. Automatic operation. Protect battery charge if current fails, enclosed model, 1 to 25 amps., 10/-.

OVERLOAD CIRCUIT BREAKERS replace fuses now. Magnetic Trip, 2 to 4 amps., 7/6; 6 amps., 10/-; 10 amps., 12/-; 15 amps., 14/-; 20 amps., 16/-.

STUD SWITCHES. 7 Stud on ebonite with plug, 1/9. Yaxley wave change, 2-gang with knob, one hole, 1/2. Reyrolle Power Plugs, 15 amp., shrouded panel wall, two pairs on iron box, unused, 10/-. Transmitters, 10 amp. Sending Relays, 15/-.

TIME SWITCHES, CLOCKDRIVE. Switch on-off any time, 6 amps., 35/-; 10 amps., 40/-, 25 amps., 55/-.

1,000 other bargains in New Sale List "W," post free.

ELECTRADIX RADIOS

218, Upper Thames Street, London, E.C.4. *'Phone: Central 4611*

PRISM RADIOGRAMS AND PUBLIC ADDRESS EQUIPMENT

PRISM MANUFACTURING CO CALIFORNIA WORKS. PRISM BELMONT, SURREY. *Phone: Sutton 5361/2.*

ANNOUNCING the "HARMONY"

self-contained dance band and public address outfit, the latest addition to our fine range. 14 watts output, and wonderful quality. Write for price and specification.

HARMONY HOUSE SOUND SERVICE

SOUTHPORT

Public address Engineers and Manufacturers of sound amplification equipment for any purpose and of any magnitude.

GRAMOPHONES, PICK-UPS AND RECORDERS

SECOND-HAND, CLEARANCE, SURPLUS, ETC.

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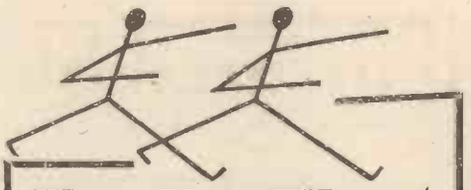

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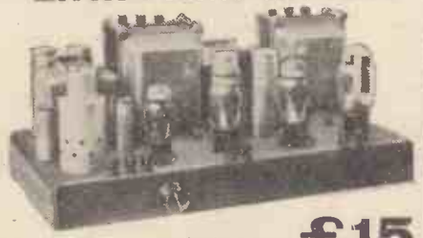

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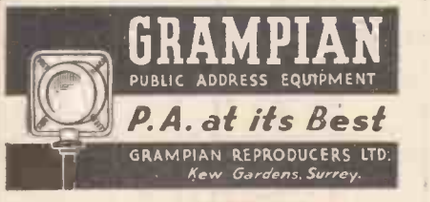

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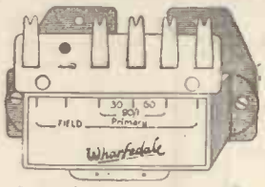

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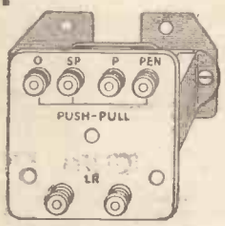

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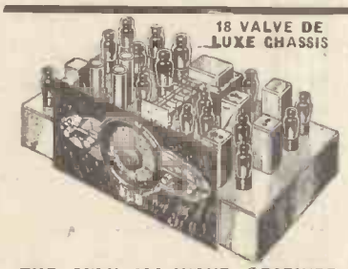

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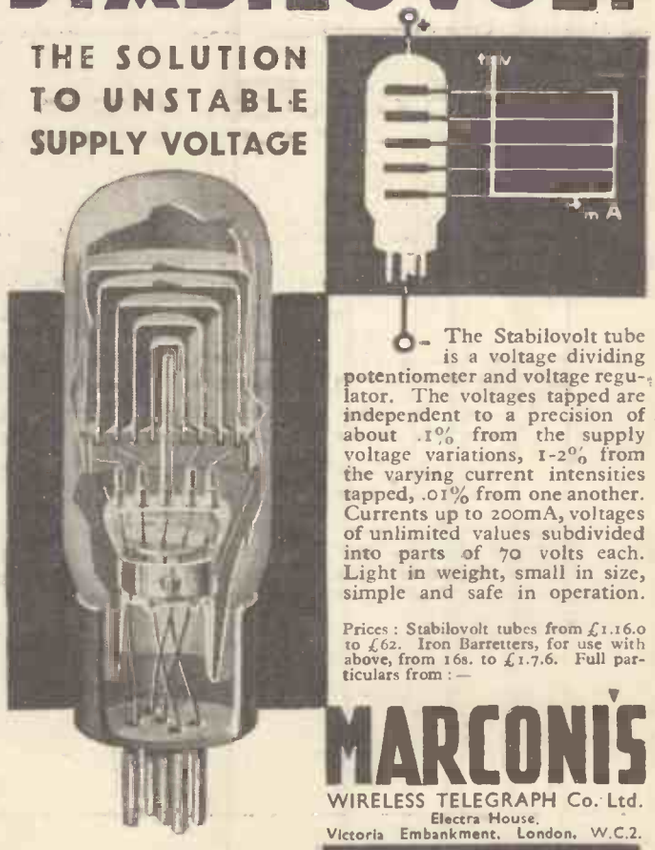

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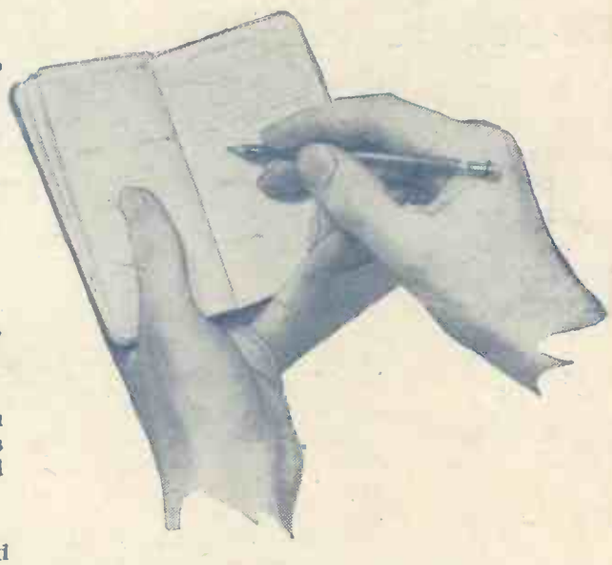

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